ARMY ORDNANCE

The Journal of the Army Ordnance Association — Now in its Nineteenth Year of Publication. Pledged to Public Service in Effecting Industrial Preparedness for War as Our Strongest Guaranty of Peace

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The Army Ordnance Association

THE Army Ordnance Association is a national organization of American citizens pledged to industrial preparedness for war as our nation's strongest guaranty of peace.

The Association endeavors to keep alive an interest in and knowledge of the design, production and maintenance of munitions. Other than a few manufacturing arsenals—six in all—there is no peace-time industry for the production of ordnance. Should war unhappily come again, industrial America will be called upon to produce munitions in great quantity and of intricate and unusual design. In an emergency, time will not permit careful study or long preparation for the production of munitions. The problem is one of vital concern.

The Army Ordnance Association believes that the solution of this problem, based on experience, lies in an active organization at all times coöperating with the Government. The principal objective of the Association is an active membership of American citizens, on whom the duty of design and production of munitions will fall in war, who will have an accurate and authentic knowledge of the complex requirements of ordnance. "Peace insurance" in this form is the foremost aim of the Army Ordnance Association.

The Association is devoted solely to the national defense; it has no commercial interests, no political alliances, and no religious affiliations. It is not operated for profit: its income is expended in furthering its aims. Its officers and directors serve without remuneration. Membership, to which American male citizens are eligible, is four dollars a year. (Application on page 254.)

ARMY ORDNANCE, the journal of the Association, is published solely for the purpose of disseminating information on the progress of our munitions developments so that American industry may at all times know its responsibilities to the common defense.

The objectives of the Association as set forth in its Constitution are:

To assist in effecting industrial preparedness for war as being one of the nation's strongest guaranties of peace;

To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect coöperation with American scientists, inventors, engineers and manufacturers in civil life and the Regular and Reserve officers of the Ordnance Department;

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

To commemorate the services rendered by the industry of the nation and by the officers and civilian employees of the Ordnance Department in the wars in which the United States has been engaged.

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ARMY ORDNANCE

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The Military Establishment

Report of the Chief of Staff for the Year 1938

By Gen. Malin Craig*

THE military establishment set up by the National Defense Act in 1920 differs fundamentally from those maintained elsewhere by the larger powers. In a special sense it is an army of the people. Its professional component, the Regular Army, is only its nucleus. Around it, the civilian components can be assembled and integrated only after an emergency arises.

The National Defense Act fixed an upper limit for the strength of this nucleus at 280,000 enlisted men. This strength it never has attained. On the contrary, in subsequent years its strength was allowed to fall to 118,500. Successive studies have indicated the grave inadequacy of this latter figure. It is a source of gratification to record that legislation enacted at the last session of Congress authorized the attainment of 165,000 enlisted men.

Our Regular Army at this latter strength ranks only eighteenth among the standing armies of the world. This marked inferiority in strength suggests that it is all the more imperative that the armament of this force be equal to that it may be called upon to face. Here, too, we fell behind. We failed to keep pace with the development in defensive weapons that has occurred since the World War.

Among the more notable innovations in that war was the development of the airplane and the tank—arms that are essentially offensive. There was necessarily a lag in time before there could be developed weapons effective for defense against these new arms. Efficient antiaircraft and antitank armament did not appear until after the close of the war. Contemporaneously there appeared new and greatly improved types of small arms and of various classes of howitzers.

Until the past year, the limited amounts appropriated annually for armament were devoted largely to the procurement of aircraft. To a lesser extent they were applied to the procurement of tanks and similar combat vehicles. Substantially little was devoted to the new defensive weapons. Fortunately, considerably larger appropriations for rearmament were made at the last session of Congress. They will suffice for the attainment of the objective of the Baker Board, and they will permit a marked reduction in the extreme shortages of semiautomatic rifles and antiaircraft armament and the initiation of the procurement of an efficient antitank weapon.

The current operations in Spain and China illustrate from day to day the greatly increased power of these new defensive weapons. They have restored to the defense the superiority it seemed to lose with the advent of the new offensive arms. It is largely because of these new defensive weapons that we find current operations confirming anew the testimony of history that the infantry is the core and the essential substance of an army. It alone of all the arms approximates a military entity. It alone can win a decision. Each of the other arms is but an auxiliary—its utility measured by the aid it can bring to the infantry.

It is a source of gratification to record also that during the past year our people seem to have come to a clearer understanding of the fact that our Army is purely defensive in type and nonprovocative in outlook. The charge that it is militaristic, that its activities menace peace, is now rarely heard. The facts are, of course, quite the reverse. Our Army has never in the slightest degree contributed to the occurrence of any of our wars. Throughout its entire history it has remained consistently within the field assigned to it by the Constitution—always wholly subordinate to the civil authorities. It has jealously guarded itself against political connections of any nature. It has remained true to its traditions—withdrawn and aloof in peace; a forward, dependable bulwark in war.

In the paragraphs which follow I shall endeavor to describe the present status of the military establishment and its more important deficiencies.

IN THE fiscal year 1938, budgetary limitations restricted the average enlisted strength of the Army to 162,000. Appropriations for the fiscal year 1939 provide for an average strength of 165,000. Heretofore, this strength has been regarded as the minimum required to provide adequate overseas garrisons and the force needed at home to perform the many tasks that devolve upon the Regular Army as the nucleus of the military establishment. It has been found, however, that a slightly larger enlisted strength will be necessary, primarily because of the increased needs of the Air Corps and of antiaircraft defense. Recent legislation authorized an enlisted strength of 21,500 for the Army Air Corps. It is hoped that the necessary additional funds will be provided to bring the Air Corps enlisted strength to this figure in the fiscal year 1940. The requirements of the whole Army in that fiscal year will aggregate a total of about 168,000 enlisted men.

The enactment of Public No. 485, Seventy-fifth Congress, third session, authorizing a commissioned strength of 14,659 is an important step toward the provision of a more adequate commissioned personnel for the Army. The first increment of the increase under this general authorization is provided

*Chief of Staff, U. S. Army. (These are excerpts from General Craig's annual report to the Secretary of War.)

in the Appropriation Act for the fiscal year 1939. This act carries, in addition to increments under the Thomason and Engineer Acts, an increase of 200 officers in the Air Corps and 75 officers in the Medical Department. . . .

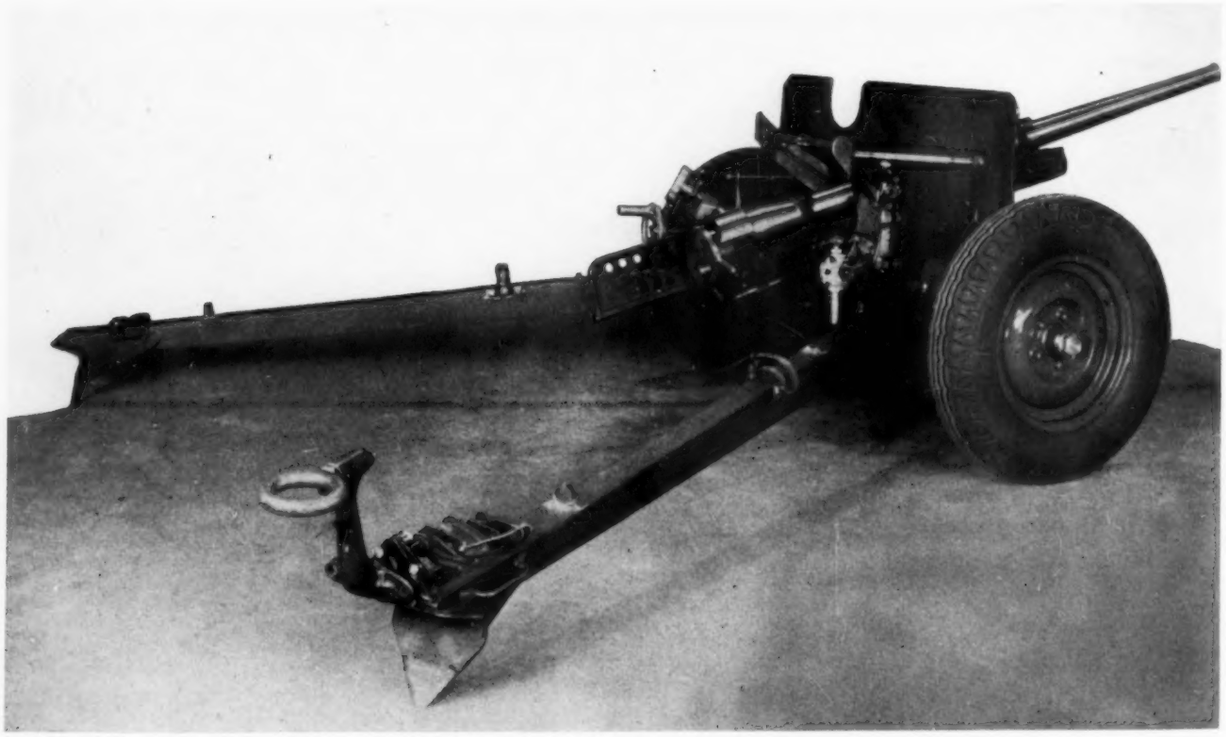
Progress in the training of the National Guard is gratifying, and its readiness for combat is believed to be at the highest point of its postwar history. Further progress has been made in obtaining equipment required for the National Guard, particularly in respect of antiaircraft armament. The appropriations for the fiscal years 1938 and 1939 will permit procurement of the major ordnance items of antiaircraft equipment required for the ten existing National Guard antiaircraft regiments. At its last session, Congress authorized an increase of 5000 in the National Guard, bringing its total authorized strength to 205,000. The ultimate objective is 210,000. . . .

THE Organized Reserves have made commendable progress during the past year. A total of 27,685 officers received active-duty training compared with 24,285 during the previous fiscal year. In addition, 4704 Reserve officers were performing duties of an administrative nature with the Civilian Conservation Corps on June 30, 1938.

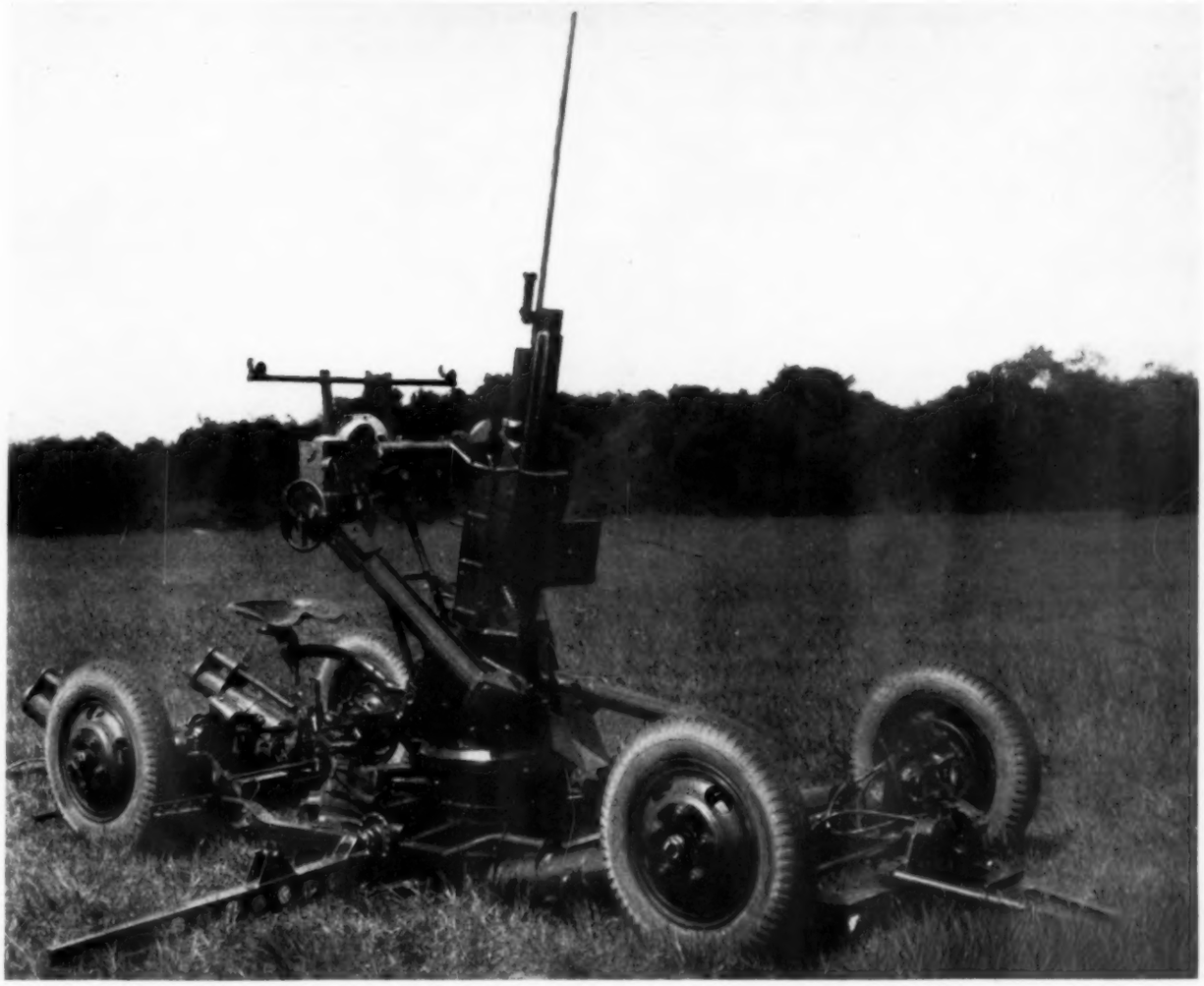
At the close of this fiscal year there were 100,116 Reserve officers on the rolls of the War Department eligible for assignment, active duty, and promotion—an increase of 3571 above last year's strength. While improvement has been noted in the discharge of command and staff functions, I consider that higher standards could be attained if a greater number of Reserve officers were sent to the General and Special Service Schools and, therefore, renew my previous recommendation that not less than 300 be sent annually. Because of increases in the strength of assignable officers and recent radical changes in the technique of warfare, 14-day training should be made available for more Reserve officers than heretofore. The rapidity with which modern wars are launched shows clearly that the time available for training after the outbreak of any emergency will be brief in comparison with our past experience. For this reason, thorough training of our organized reserves in time of peace is imperative.

Interest in the Reserve Officers' Training Corps is increasing steadily. Applications on file have more than doubled during the past year. The new programs of instruction for R.O.T.C. courses, inaugurated at the beginning of the academic year 1937-1938 are regarded as a distinct improvement. The continued increase in junior- and basic-course enrollments has resulted in requests for a corresponding increase in advanced-course enrollments. These requests could not be met because of limitation of funds. It is desirable that additional funds be provided to permit an increase of about twenty-five per cent in advanced-course enrollments, or a total of about eighteen thousand. Shortages in Regular Army commissioned personnel have precluded meeting the requirements for R.O.T.C. instructors. Until these shortages are met, it will not be practicable to establish new units.

A total of 57,073 applications were received for training at Citizens' Military Training Camps, 36,259 were authorized to attend, 33,445 reported, 32,522 were enrolled, and 31,239 completed the month of training. This is an increase of three per cent over the number completing the training last year. This form of training continues to be popular. In addition to the benefits derived by the trainees, and the opportunity given them to qualify for a commission in the Officers' Reserve Corps, it is of value in the training of



THE NEW 37-MM. ANTITANK GUN AT MAXIMUM ELEVATION ON MOBILE CARRIAGE



THE NEW 37-MM. ANTIAIRCRAFT GUN IN FIRING POSITION ON MOBILE CARRIAGE

the Reserve officer instructors in the problems of actual command.

In authorizing the reëstablishment of the Regular Army Reserve, Congress at its last session restored an essential element of the national-defense structure. This Reserve will be made up of men who, upon completion of an enlistment in the Regular Army, elect to return to civil life but are willing to enroll in the Reserve and thereby assume the obligation to return to active service in an emergency. Since they are thoroughly trained, they can be utilized immediately in front-line units. Enlistment in this Reserve began on July 1, 1938. The expected strength of 75,000 will not be reached for several years because only men who have completed an active tour of service will be eligible for the Reserve. The yearly increment thus will depend upon the number of qualified men leaving the service during the year.

Working harmoniously with other Government agencies, the War Department continued to perform its administrative functions with respect to the Civilian Conservation Corps. The authorized enrolled strength was 300,000. The maximum number of camps in operation during the year was 1849 and the minimum 1501.

The major factor that determines the composition and organization of a military unit is the character of its equipment. So changes in weapons or in other types of military equipment must find their reflection in corresponding changes in organization. The subject is one of continuing study. It is in recognition of the evolution in equipment that has occurred since the World War that there was instituted the test of the greatly modified Infantry division described in my last report. The first phase of the test has been completed, but further experimentation will be had before an attempt is made to reach definitive conclusions as to the type of divisional organization to be adopted. For the same reason a field service test of an experimental Cavalry division was conducted in the Eighth Corps Area during the past year. The reports of the test still are undergoing study.

OTHER changes in organization that have occurred in the Regular Army include the addition of two batteries of field artillery to the mechanized brigade at Fort Knox, the organization of an additional regiment of antiaircraft artillery (at Fort Winfield Scott) and the organization of an additional Signal Company (at Fort Des Moines).

In the National Guard, progress is continuing in the organization of the additional units permitted by the second increment of 5000 men.

Progress has been made in the training of all components of the Army. Careful planning by all concerned in the use of field-exercise and normal training funds have enabled

almost all mobile units of the Regular Army to participate during the year in practical field exercises of the combined arms.

The two major exercises which gave valuable training to all components of the Army were the Fourth Army maneuvers conducted in the Seventh and Ninth Corps Areas, and the First Army command-post exercise held at Fort Devens, Mass. Other major field exercises conducted during the year include the extended field tests of the experimental Infantry and the experimental Cavalry divisions; GHQ Air Force maneuvers in the Middle Atlantic seaboard, and joint Army-Navy exercises along the Atlantic seaboard and the Caribbean.

The benefits resulting from these field exercises are regarded as having more than justified their costs. Commanders and staffs obtained practical experience in the planning and conduct of operations of large units under present-day conditions, and the troops have had the benefit of practical field training under conditions simulating war conditions to the extent possible.

FURTHER progress has been made in providing the Army with modern equipment. In certain essential and critical items of equipment discussed in detail below, there are, however, marked shortages:

Antiaircraft.—The extreme shortage of antiaircraft material has been relieved, in part, by the Appropriation Act of 1939. In consequence it will now be possible to provide the major items of ordnance equipment for the fifteen active antiaircraft regiments of the Regular Army and National Guard, and to accumulate in war reserve stocks of certain critical items. Further appropriations, however, will be required for armament, searchlights, and fire-control equipment.

Antitank weapons.—An imperative need is that of antitank armament. Our Army at present is wholly lacking in an effective weapon of this type. One has been developed by the Ordnance Department and will be supplied to the limited extent permitted by the appropriation for the fiscal year 1939.

Mechanization.—The light tank program of the Regular Army has been completed. A modern medium tank has been developed and a program for meeting requirements in this weapon will be initiated in fiscal year 1939. The initial equipment of the mechanized Cavalry brigade, including its artillery component, has been completed. Future programs will provide for essential replacements and expansion.

Field Artillery matériel.—The program to equip the active units of the Regular Army with the modernized 75-mm. gun is nearing completion. The modification of artillery matériel for high-speed transport is completed with active units, and a considerable number of guns in reserve have been thus modified. The development of a new 105-mm. howitzer for divisional artillery is well under way.

Airplane procurement.—Great progress has been made toward the attainment of the Baker Board objective. Funds provided in fiscal year 1939 will permit the completion of this objective. The Air Corps now is being equipped with airplanes and matériel that are equal, if not superior, to any military airplanes in design, speed, endurance, and suitability for the military use for which intended. This was convincingly demonstrated in February of this year by the record-breaking flight to Argentina by six U. S. Army bombers of the 2nd Bombardment Group to participate in the inaugural ceremonies at Buenos Aires. These airplanes with normal crews, equipment, and training gave a demonstration of speed, range, and navigation accuracy unexcelled by any military airplanes in the world.

Miscellaneous equipment.—The caliber .30 semiautomatic rifle is now under manufacture in quantity at a greatly reduced price, and its issue to units is proceeding under a program which will equip both the Regular Army and the National Guard. Substantial reductions are being made yearly in the shortages in other infantry weapons, searchlights, radio equipment, and gas masks.

Motorization.—With the funds made available for the fiscal year 1939, the motorization program will become approximately sixty-seven per cent complete for the Regular Army and fifty per cent complete for the National Guard.

Seacoast defense.—The program of modernization and augmentation of the seacoast defenses of the continental United States, Hawaii, and Panama, begun in the fiscal year 1937, has progressed satisfactorily. Additional funds for this purpose will be available during the coming fiscal year.

FOLLOWING the adoption of the Protective Mobilization Plan, an exhaustive study was made of the war reserves for the accomplishment of that plan. Articles of a purely military character cannot be obtained promptly from commercial sources upon the outbreak of war. They must be procured in time of peace and held in war reserve. The quantities of each of these items that should be provided in war reserve are those that will be needed to meet the requirements of the plan during the period that will elapse before industry can obtain a rate of production adequate to meet the then current military needs.

The total cost of the war reserves required for the Protective Mobilization Plan is considerably less than that of the plan that it superseded. Nevertheless, our present war reserves are far short of requirements in a number of critical items. The situation will be improved to some extent through the funds that will be available during the ensuing fiscal year, but large shortages still will remain. The removal of these shortages is a matter of major military importance.

As a result of the appropriations made during the last session of the Seventy-fifth Congress and of allotments from the Public Works Administration and the Works Progress Administration, there have become available funds sufficient to accomplish permanent construction in the Army to the total value of $66,845,737. This sum will go far toward meeting the most urgent needs in Army housing. It will alleviate crowded conditions in a number of posts, as well as permit the removal of many temporary buildings constructed during the World War. . . .

In submitting this report I should be remiss were I not to call to your special attention the unwavering support which I have received during the past year from officers and men throughout all ranks and grades of every component of the Army. This whole-hearted coöperation has been invaluable to the War Department. It has resulted in an organization keenly alert to the nation's needs, and one which I believe exceptionally well trained. The rank and file themselves are responsible for the efficient state of training which exists in the Army today and I wish to accord them full credit for the achievement.

Arms for the Army

What We Have and What We Need for Ordnance Preparedness

By Maj. Gen. C. M. Wesson*

I WOULD, at the outset, have you know how deeply conscious I am of my responsibilities as the head of the Ordnance Department because I believe that the success of our armies in the field will depend largely on whether or not the mission assigned to the Ordnance Department is carried out effectively.

Never before in our peace-time history has the matériel problem received the recognition by those in authority that it is receiving today. We have as our distinguished Secretary of War a man who served for a long time as the Assistant Secretary of War, in which office he became apprised of the necessities of matériel preparedness as well as the utilization of man power. You no doubt read almost daily of the activities of the ubiquitous, dynamic, able Assistant Secretary in the furtherance of procurement planning. As for our Chief of Staff, I will quote some of his remarks on this subject at the opening of the Army Industrial College in September:

"Only a relatively few years ago the main worry of the Army leaders was to work out a quick and efficient system for mobilizing, training, and utilizing man power. Now to this task is added the still greater one of working out a quick and efficient system of mobilizing, utilizing, and augmenting the supply resources of a country to support the man power. I say this latter task is the greater one and I believe it, for the mobilization and development of the supply power of the country covers a broader and more complicated field and, in general, requires several months longer for its accomplishment."

Before undertaking a description of the operations of the Ordnance Department, we might well devote a few minutes to a consideration of what the Ordnance problem really is.

It is a responsibility of the Department to supply our troops with Ordnance matériel in the quantities needed and at the place and time required. More specifically, this responsibility carries with it the design, development, procurement, storage, issue and maintenance of practically every offensive and defensive implement essential for the successful prosecution of war.

The diversity of the problem and its technical aspects are indicated by the fact that there are over 1200 separate items together with some 250,000 components in the general categories of cannon and their mounts, rifles, pistols and machine guns, fire-control instruments, tanks, combat cars and scout cars, bombs and pyrotechnics, and all types of small-arms and artillery ammunition. These items are noncommercial and embody in their design the application of every phase of science and, in the main, can be designed successfully only by specially trained engineers—men who are not easily obtainable, since industry does not produce comparable matériel, and men for the most part who have grown up in the Department.

The magnitude of the operations of the Department in peace and in war is indicated by the appropriations made to the Department from year to year. The appropriations ran from ten to twelve million dollars per year prior to the World War, increasing somewhat just before our entrance into that conflict. They were tremendously increased during the war years, amounting to over four billion dollars for the fiscal year starting July 1, 1918. From this, you can readily see the enormous expansion of Ordnance activities in time of war.

Several years after the war, appropriations were about the same as those before the war, but the much higher cost of labor and material reduced activities. This condition existed, notwithstanding the fact that during this postwar period the total appropriations made to the War Department were considerably greater than the prewar appropriations.

Since the fiscal year 1936, a considerable increase has been made in our appropriations, and during the current year you will note that they are approximately fifty-three million dollars, which, however, includes a thirteen-million-dollar contract authorization. In addition, approximately four million dollars was appropriated for the procurement and maintenance of Ordnance matériel for the National Guard and the seacoast defense. We also are doing work aggregating several million dollars for the Navy Department, so that our program this year is running over sixty million dollars.

If we can continue on an appropriation basis such as this year, we can make some progress in meeting the deficiencies in Ordnance matériel which now exist. In my judgment, however, still greater appropriations are required.

THIS year some of the principal items which we are procuring by manufacture and purchase are: antiaircraft guns, mounts, and fire control; bombs of assorted sizes, smokeless powder, TNT, ammonium nitrate, medium tanks, semiautomatic rifles, machine guns of .30 and .50 caliber for aircraft and antiaircraft, sound locators, and in addition we are renovating several thousand rounds of ammunition.

We also soon will initiate the manufacture of 37-mm. antiaircraft guns and mounts, 37-mm. antitank guns and mounts, and we are buying some six million dollars' worth of special machinery, of which $1,800,000 will be used for the production of the semiautomatic rifle, and the remainder, being special machinery difficult to procure, will be held for the production of small-arms ammunition, smokeless powder, ammonium nitrate, etc.

Approximately twenty-five million dollars' worth of material will be procured this year from industry. Awards are made as a result of competition, and the preparation of specifications and analysis of bids is a big task. Up to October 15th, awards to industry aggregating over nineteen million dollars had been made. These awards have gone to several hundred firms in the industrial sections of the United States where our inspection organization is being built up to carry the increased load imposed by these orders.

No Chief of Ordnance can but feel concerned as to the ability of the Department to meet its war task so long as its available stocks are insufficient to meet the needs of the

*Chief of Ordnance, U. S. Army.

Current Types of Howitzer Carriages

Acme

THE NEW 75-MM. HOWITZER CARRIAGE

This weapon on pneumatic-tired carriage, recently developed by the Ordnance Department, is being drawn by horses in U. S. Army maneuvers at Fort Riley, Kans. to determine the adaptability of the piece to meet conditions of terrain.

Acme

THE NEW 155-MM. HOWITZER CARRIAGE

This truck-drawn piece on pneumatic-tired carriage is being taken into battle position at the Fort Riley maneuvers where an army supported by motorized cavalry and artillery opposed one supported by horse cavalry and artillery.

Army until production is under way and in sufficient volume to supply requirements. The Department is far short of being in a satisfactory condition. Until shortages are made good, we naturally must have a justifiable concern.

Woe betide that Chief of Ordnance who, in an emergency, finds himself unable to meet the demands of our troops for munitions of war. The martinetic viewpoint which at times I have heard expressed—"off with his head"—will not compensate for failure to provide the necessary war-reserve stocks before the storm breaks. In our studies as to what war-reserve stocks should be provided, let us not forget the classic observation of General Harbord that, no matter where a war starts, in the air, on the water, or where you will, it always winds up in the mud.

In attempting to solve the Ordnance problem, we have resolved it into two major components: First, *provision,* which is research and development, procurement, and procurement planning; second, *distribution,* which is storage, issue and maintenance, and war plans for same. Our organization and operation are designed to attack the problem on these two fronts.

THE operations of the Department are directed, of necessity, from the Office of the Chief of Ordnance in the War Department, which has a peace complement of 38 officers and approximately 200 civilians. This force would be increased in a major war to approximately 360 officers and 2000 employees.

In general, the provision responsibility of the Department, that is, the design, development and procurement of matériel, is the responsibility of the Industrial Service of the office; the distribution activities of the Department—the storage, issue and maintenance functions—are the responsibility of the Field Service. These two are the operating agencies of the office. Two other agencies, the staff agencies, are the General Office and the Technical Staff. No material change in the organization for war is contemplated other than expansion. Some of the present sections would become divisions with their own subsections.

The several divisions of the General Office perform the various administrative and overhead functions of the Ordnance Office, such as fiscal, personnel, general administration, and war planning.

Now before a producing organization begins to produce, it first of all must know what it should produce. The Sears-Roebuck catalogue is prepared by a consideration of a hundred different factors, such as the trend of styles in women's and misses' dresses, the latest type of mechanical toys, the buying power of its clientele—which depend on the price of hogs in Arkansas and apples in Oregon and cotton in Dixie—and whether bathing suits will be more skimpy next summer than last.

The Ordnance catalogue is the "Book of Standards," which shows for every item of Ordnance stores the standard or substitute standard approved by the General Staff for the equipment of our troops. How does an article get into this book? We shall see. In the first place, our clientele are the arms of the service. The members of the Technical Staff are ex-officio members of the Ordnance Committee, and through this committee the Ordnance Department maintains contacts with the using arms as to the type of equipment desired by them. It collaborates with them on the questions of military characteristics, which eventually are forwarded to the General Staff for approval. The organization must be technical because military characteristics must be reasonably possible of attainment by known engineering methods.

When a development project for an item of matériel has been definitely set up, the Industrial Service is called upon for a design. But before construction is started, the Technical Staff must give its approval thereof to determine whether it meets the prescribed military characteristics. This staff also supervises all tests of matériel while in the experimental stage and collaborates with the using services in the service test of experimental equipment. In fact, its responsibility does not end until the item has been found to be satisfactory by the using arm, approved by the Assistant Secretary of War for procurement, and finally set up by the Secretary of War as a standard item and entered in the Book of Standards. Another very important duty of the Technical Staff is to direct basic and technical research activities along lines which may lead to further improvement in Ordnance matériel.

THE responsibilities of the Industrial Service are three: (1) research and development, (2) procurement, (3) procurement planning.

Research and development are responsibilities of the first magnitude. If we were in that fortunate position where the types of our equipment were the best of every kind in the world and were likely to remain so for an indefinite time, there would be little need for research leading to the development of new and improved designs. Unfortunately, this is not the case. Other nations are continually developing new types of combat equipment and effecting improvements in existing types. The Ordnance Department must be alert as regards engineering and scientific developments which, though not primarily military in character, may be used in producing more efficient fighting equipment.

Not only this, but there are certain research activities which must be carried on directly by the Ordnance Department because industry itself conducts no research along these lines. In this category comes the science of ballistics, both interior and exterior, which in itself is an extremely broad field involving shapes of projectiles, rifling in guns, composition of powder, shape of powder chambers, methods of ignition, method of banding projectiles, shape and size of powder grains, all types of fuzes and bombs, and other items too numerous to mention. In this category also come the complicated problems of fire control. In the automotive field come the problems of tracks and track suspensions for high-speed track-laying vehicles, special transmissions for handling powerful motors, and the cooling of engines under adverse conditions. In fact, I could devote pages to the problems which may be classified as Ordnance engineering peculiar to the Ordnance problem and not solved by industrial research.

This phase of the Ordnance problem, in my judgment, never has received sufficient recognition; it never has received adequate funds. We have been limited for years to an amount slightly over one million dollars for all research and development work. Out of this amount must come, not only funds for research, but also the cost of designing and building new and improved types of equipment, and all tests, both engineering and service, including the necessary ammunition in connection therewith. There are 496 research and development projects on our books today.

When we consider the broad and complicated field which the Ordnance research and development problem presents

and the amount of money spent thereon as compared with amounts of money spent by such corporations as the DuPont Company ($6,000,000), General Motors ($20,000,000), A. T. & T. Company ($20,000,000), and the Westinghouse Electric and Manufacturing Company ($16,000,000), whose products are very much more restricted in scope than ours, I believe that my opinion may be well justified.

When it comes to the problem of producing designs to accord with the military characteristics laid down by the General Staff, to produce stationary and mobile weapons at least the equal of those available to other nations, one never can lose sight of the fact that these items are noncommercial; *i.e.*, in general, they have no counterpart in commerce. Since, however, the great bulk of military supplies required in war must be produced by private industry, it is essential that the designs, so far as possible, be susceptible of quantity production by commercial manufacturing methods. Every effort, therefore, is made to incorporate in these designs articles of commercial manufacture wherever it is possible to do so.

In order to meet the foregoing conditions, we must of necessity keep ourselves informed of three things: (1) Scientific developments which may have military application; (2) Types of military equipment developed by foreign nations; (3) Commercial developments which may be applied to Ordnance designs.

THE second responsibility of the Industrial Service—procurement—involves two functions—manufacture in Government arsenals and procurement from industry. The manufacturing arsenals of the Ordnance Department where these manufacturing activities are carried out are Watertown, Mass. (established 1816), Springfield, Mass. (1795), Watervliet, N. Y. (1813), Picatinny, N. J. (1880), Frankford, Pa. (1815), and Rock Island Arsenal, Ill. (1863).

Springfield Armory is the center of small-arms development and manufacture. During the war it had a capacity for the manufacture of 1000 caliber .30, model 1903, rifles a day. Much of this capacity now is being converted to the manufacture of semiautomatic rifles.

Watervliet Arsenal has the machine-tool equipment for the finish machining and rifling of cannon and the manufacture of breech mechanisms for all calibers.

Picatinny Arsenal is the ammunition arsenal of the Ordnance Department and has capacity, on a production basis, for the loading and assembling of complete rounds of artillery ammunition and bombs and the manufacture of certain components therefor, including smokeless powder, fuzes, primers, and boosters.

Frankford Arsenal has the most diversified work of any of the arsenals. Its products include fire-control instruments, metal components of artillery ammunition, and small-arms ammunition of all types.

Rock Island Arsenal, located on an island in the Mississippi, is equipped to manufacture mobile gun mounts, tanks, and other automotive equipment. A plant in stand-by condition also is located there for the manufacture of Springfield rifles, Browning automatic rifles, and machine guns. Last year, Rock Island completed seventy-five years of service to the Army.

Watertown Arsenal is equipped to manufacture medium and heavy gun mounts. As a result of development work conducted there since the war, the arsenal now is equipped to produce centrifugally cast gun tubes and to cold-work them by interior hydraulic pressure. Guns thus produced are more cheaply and quickly manufactured than by former processes and are stronger for equal weight.

These arsenals are important elements in the operations of the Department. In time of peace, they assist in the development of new designs and the improvement of existing matériel. We depend on them for production, at least in sufficient amounts to uncover production difficulties, standardize methods of manufacture, and determine costs. It is mainly through the arsenals that the art of manufacture of ordnance is kept alive. They serve as centers for the training of personnel in both peace and war, and provide a nucleus of trained personnel to assist in the inauguration of mass production. During the early months of war, before commercial facilities can begin production, they are our main source of manufacture of matériel required for the supply of the troops mobilized. In order that the arsenals may be prepared to perform these important functions, it is essential that they be given sufficient manufacturing orders each year to maintain them on a reasonable operating basis at all times.

It should be understood that these arsenals are not completely integrated manufacturing establishments equipped to convert the products of mine and forest into finished articles of ordnance. Such is not the case. In general, the raw materials of an arsenal are the semifinished materials of industry; such, for example, as metals in the form of forgings, castings, sheets, strips, bars, rods and shapes.

The arsenals procure these semifinished materials from commercial sources where they are produced in quantity for industrial uses and continue the processing from that point by machining, heat treating, fabricating and assembling them into finished articles of ordnance.

Further, all commercial items of ordnance are procured from commercial sources, as well as certain finished major components which the arsenals are not equipped to manufacture. These include tank engines, armor plate, and transmissions.

There also are located at the arsenals and at the Aberdeen Proving Ground the laboratories engaged in research pertaining to interior and exterior ballistics, optics, acoustics, ferrous and nonferrous metallurgy, chemistry of propellants and explosives, and automotive research. The policy of the Department in research is to undertake only that research which is necessary for progress and which is not conducted by private enterprise.

The present manufacturing arsenals could produce only a small proportion of the Ordnance matériel required in a major war. It is estimated that the arsenals produced less than five per cent of the Ordnance matériel procured from all sources during the World War, and they will be expected to produce about ten per cent in any future major war.

There will be no increase in the number of manufacturing arsenals in time of war, nor is it planned that there shall be any material expansion of facilities at any of the existing arsenals. To permit our arsenals to undertake a large expansion of production facilities after the outbreak of war would interfere seriously with early production. The existing production facilities will, of course, be used to full capacity and there will be a very great increase in the number of employees to man the available equipment and use it to its full capacity.

It is highly desirable that private industry be given an opportunity to manufacture noncommercial items of ordnance. Not only does this give private industry an opportunity to gain experience in ordnance production, but it also serves to prove that our designs are susceptible of quantity production by industry in time of war. For this reason, orders for finished items of ordnance are placed with commercial manufacturers each year to the extent practicable within the funds appropriated and in conformity with the laws governing competition. These orders are normally placed through the arsenal responsible for the manufacture of the type of matériel to be purchased. That arsenal is responsible for placing the order, and for inspection, acceptance, and payment for the matériel.

For many years following the war—until the last year or two—the annual appropriations available were so limited that comparatively few articles of Ordnance matériel could be procured directly from industry. Purchases from industry were confined to those supplies required by the arsenals in producing the orders assigned to them. In fact, the appropriations were so meager that it was extremely difficult to operate the arsenals on anything like an efficient basis and to maintain a nucleus of trained personnel to keep alive the art of production. The fact that we were able to obtain substantial orders from the Navy prevented the closing down of some of the manufacturing arsenals. I am happy to report that this condition is greatly improved by the increased appropriations for the current year, and that approximately forty per cent of the matériel under this program will be procured directly from private industry.

To avoid delays and confusion in the early period of war, we must know in advance not only what items are to be provided, but also how many of each item, when and where they are required, and where they can be obtained. These are the facts upon which procurement planning is based.

THE volume of ordnance which must be supplied by industry in a major war is so great that its procurement must be decentralized to the fullest extent possible. That was clearly demonstrated during the World War. The term "procurement" covers the negotiation of contracts, placing of orders, administration of these contracts, inspection of the finished material, and payment therefor. In order that this work may proceed promptly and efficiently, it is necessary that procuring agencies be located convenient to all the principal industrial production centers of the country.

While our arsenals do perform this function to a limited extent in peace, the volume of procurement in war would be so great that they would be "swamped." They would be fully occupied in getting into production the munitions required in the early months of war and in carrying out their other essential functions. Furthermore, they are not sufficient in number nor, in general, suitably located with relation to industrial production centers.

We therefore have established fourteen procurement districts. This system and organization for war procurement, which I am about to describe, is in conformity with the procurement policies and plans of the Assistant Secretary of War. In time of peace, these districts function as procurement-planning agencies, and in time of war, as procurement agencies. Recently, we have assigned a large amount of inspection work to these districts and have had to increase their officer and civilian personnel.

Procurement planning for war is conducted both in Ordnance districts and at the manufacturing arsenals, each for its allotted war task.

The peace-time organization of each district is headed by a district chief and an assistant district chief, both of whom are industrialists, well known and highly respected in their community, and who are thoroughly familiar with the industrial activities of the district. They are assisted by a commissioned officer of the Ordnance Department.

After the determination of requirements for Ordnance items, as has been explained, apportionments are made to the various districts in definite quantities for delivery by months. District planning begins at this point. Surveys of facilities are made to determine those best fitted to manufacture each specific item, after which the required capacity of the facility to undertake a definite schedule of production is obtained by allocation of the plant to the Ordnance Department, or by the approved reservation of a portion of the plant.

The facilities so allocated or reserved are furnished drawings, specifications, descriptions of manufacture, and in some cases samples of the items scheduled, by which means it is possible in working with the procurement representative to make a production analysis for a proper understanding of the problem of plant conversion and a determination of any deficiency which may exist in the machine tools and other processing equipment.

No attempt is made to enter into contracts with these manufacturers, but an acceptance of the proposed schedule of production is obtained from each plant if possible. This is, in effect, a statement by the manufacturer that his plant will be able to produce the item in question in the quantities and at the rates specified, and that he will be willing to enter into a contract for its production in an emergency.

Based on the work in the districts, the Industrial Service, Office of the Chief of Ordnance, prepares a procurement plan for each essential item, which, in brief, shows the apportionments made and the accepted schedules of production thereunder. There are 575 essential items selected for planned procurement, and the plans for the entire number have been completed.

SINCE the bulk of Ordnance matériel must be procured from industry in war, produced by firms which must change over their production set-up to fabricate the item assigned them and develop a production technique for this item, much time will be saved if, during peace, they gain experience in the manufacture of the particular item charged to them. To meet this situation, the so-called "educational order" has been evolved, and during the current year Congress has authorized the expenditure by the War Department of $2,000,000 of War Department appropriations for this purpose. The Ordnance Department's share of this is $1,000,000. Under this authorization, bids for the manufacture of items of ordnance may be solicited from a selected list of prospective manufacturers, the award to be made on the basis of the best interests of the Government and not necessarily to the low bidder.

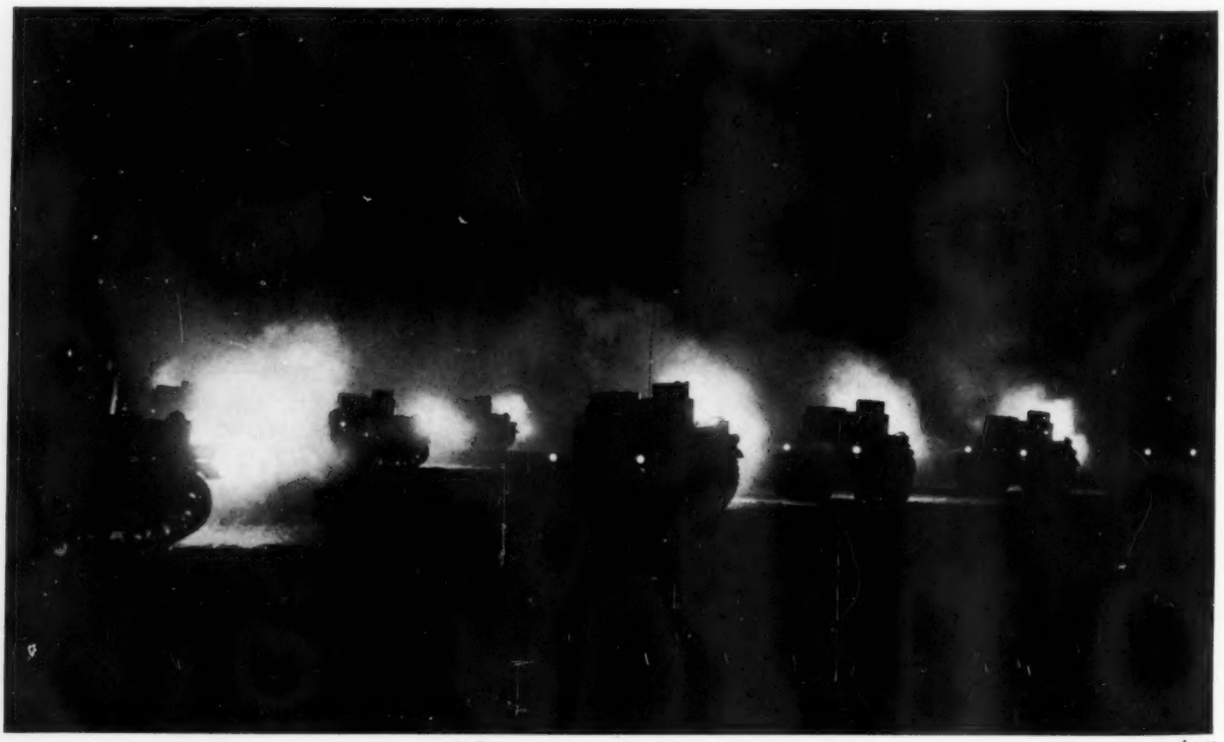
Thus it will be possible to place orders for the manufacture of a few important items of ordnance with certain manufacturers on whom we count for war production. The quantities of ordnance procured in this way will be small. The important point is that the manufacturer will gain

Light Tanks in Recent Field Maneuvers

Acme

ATTACK BY DAY

Emerging from a protective smoke screen, a group of light tanks moves over rough ground in support of infantry during maneuvers at Fort George G. Meade, Md., to demonstrate the use of light tanks in advancing on enemy positions.



Acme

ADVANCE BY NIGHT

Light tanks of the U. S. Army move forward in maneuvers at Fort George G. Meade, Md., using flares in addition to their headlights to illumine the terrain during the advance.

experience in the manufacture of the matériel he is expected to produce in war. The present amount devoted to this purpose is small, but will furnish an opportunity to see what may be accomplished by this line of approach.

Another difficulty is that certain special machinery which requires a long time to produce is not available in sufficient quantity in the United States. We, therefore, have a special machinery project amounting to $33,500,000, toward which there was appropriated this year some $3,700,000 which will be applied to machinery for powder making, special equipment for shell-loading plants, machinery for the manufacture of small-arms ammunition, and equipment for the centrifugal casting of cannon tubes. This machinery will be held for use in an emergency. In addition, there was provided $2,300,000 for machinery required for the current production of the semiautomatic rifle and machine guns.

There are a great many other time-consuming difficulties attendant upon the initiation of a war production program; such as the lack of skilled workmen, large deficits in general machine tools, etc. A solution for these problems in time of peace is most difficult of attainment.

IN A WAR involving smaller military forces, the requirements for supplies naturally would be correspondingly less and the procurement load on private industry would be correspondingly reduced. This reduction in the procurement load would be met in part by the elimination of those manufacturers having schedules of production for a given item which are least prepared to produce the item in question, placing orders with those best equipped for the work, and in part by distributing the reduced load for the item among all facilities having war schedules. As a matter of fact, both methods would be employed depending upon the situation with reference to each item.

In my opinion, too little attention has been paid in the past to this phase of planning. Heretofore, there has been a tendency to think only in terms of procurement for the so-called maximum effort. I think I have made it clear that many of the details connected with procurement will vary widely depending upon the volume of supplies required to meet the needs of varying military situations. Our plans should be such that we can initiate procurement promptly on M-day for supplies in the quantities needed for any military effort from the smallest to the maximum.

I shall now discuss the functioning of this procurement system on the outbreak of war. It is apparent that, before a war procurement program can be initiated, the Department must know the approximate size of the military force which the War Department contemplates mobilizing. To initiate procurement on the basis of 3,000,000 men when a force only one-half or two-thirds that size will be organized, will result in waste of time, energy, and money in the expansion or development of facilities for the production of supplies not in fact required. This will cause delay in the supply of matériel actually needed during the early months.

On the other hand, I particularly wish to emphasize that once having committed ourselves to a procurement program on a certain basis, it is not possible to suddenly step up the production rate in the midst of war. Material increases in the production rate will require time. If, for example, procurement is initiated on a certain basis and a decision is suddenly arrived at in the sixth month to double or triple that force, such a decision cannot be made immediately effective, except to the extent that the required supplies are already in the storehouse. We fully realize that any plan of mobilization adopted initially will be subject to frequent changes as the war progresses, resulting in changed requirements for supplies, but every effort must be made to foresee our needs and eliminate sudden changes.

WITH basic information available as to the approximate size of the force to be organized, the Department should be ready to put its procurement plans into effect at once. Estimates of the funds required must be submitted. The Ordnance Department will be in a position to submit these estimates promptly. Of course, we have no control over the action of Congress, but I believe it is reasonable to assume that if Congress votes for a declaration of war, it will not long delay the action necessary to provide the funds required for its successful prosecution. In any event, pending the passage of the appropriation act, remaining balances under current appropriations could and would be used to inaugurate the most urgent steps necessary to get the program under way promptly.

Simultaneously, the procurement districts will be notified of the size of the contemplated procurement program and directed to proceed with procurement. Each district will immediately organize on a war footing, and begin at once the negotiation of contracts with the manufacturers with which it has schedules of production for the procurement of supplies required by the contemplated military effort. In so far as possible, fixed-price contracts will be used, although it is recognized that this form will not be applicable in many cases, and provision has been made for the use of an adjusted-compensation form of contract where necessary. Standard contract forms have been prepared, and in the usual case the main condition remaining to be settled is that of price. These negotiations can be carried on and the contracts prepared for final signature prior to the receipt of formal procurement authorities legally authorizing the execution of contracts.

Briefly, then, the essential steps in inaugurating the war procurement program are: (1) A directive from the General Staff giving the approximate size of the force to be mobilized; (2) Submission of estimates of funds required; (3) Instructions to the districts stating the procurement program in effect; (4) Negotiation of contracts by the districts with the manufacturers selected in peace time to produce the supplies required. Actually, it will not be as simple and automatic in operation as it sounds. The small nucleus of personnel in the peace establishment will be working under tremendous pressure getting the procurement program under way, at the same time building up the organization by bringing in the additional personnel needed for the very great expansion involved.

And now a word about the geographical distribution of the Ordnance war production load. As I have stated, more than ninety per cent of the supplies to be procured in a war of maximum effort must come from private industry. In this country the locations of commercial manufacturing plants have been dictated by peace-time economic considerations. These industrial areas may or may not be strategically safe, but we must accept the situation as it exists. The industrial effort involved in a maior war is so great that, broadly speaking, all available suitable industrial capacity must bear its share of the burden.

When we break down the Ordnance war procurement into classes of items, we find that the northeastern section of the United States has a far greater importance to our war program than the average figures indicate. For example, inspection gages are vital to the procurement of all classes of Ordnance. Ninety per cent of the gages required for the procurement program will come from the New England and North Atlantic States and of this more than eighty per cent is from New England, for the simple reason that the industry now is concentrated there. The manufacture of gages requires special facilities, specialized knowledge, and highly skilled workmen, all of which cannot be uprooted and transplanted to another section overnight.

Commercial capacity for the production of gages in the Midwest is increasing, and it is probable that continued study will result in some improvement with relation to gages, as well as other items of ordnance where the load on the Middle Atlantic and New England States is abnormally heavy, but it is clear that we must depend to a very considerable extent on this section as a source of production of the ordnance supplies required in war.

For the loading of artillery ammunition, commercial facilities are nonexistent. The few Ordnance facilities available, or possible of conversion to this purpose, are located mainly along the Atlantic seaboard, south of New York. While their output will be small compared with the monthly quantities ultimately required, they will be the sole source of production during the first seven or eight months of war. For the loading of the great bulk of ammunition ultimately required in a major war, it is planned to erect new plants, all but one of which will be located west of the Appalachians.

I NOW shall proceed with the other prime responsibility of the Department—the problem of distribution. The activities which fall under this heading are directed by the Field Service group of my office and embrace the important functions of orderly storage and prompt issue of all Ordnance stores, their preservation in storage and their maintenance in service. In addition, this group is responsible for the plans for executing these functions in war.

Preservation and maintenance of Ordnance matériel include specifically its inspection, repair, overhaul, and modification. From an operating standpoint, equipment and stores are divided into two categories: (1) Those actually issued to organizations plus that at Army posts under the control of the corps-area commanders and (2) those at Ordnance depots.

For the first category, the work involved is supervised by corps-area and department Ordnance officers. At the larger Army posts, efficient performance requires shop facilities, stocks of spare parts, and skilled labor. In addition, there are provided for field operations mobile repair shops and certain light repair trucks. Cargo trucks with standard commercial bodies are used for the transportation of spare parts.

With the ever-increasing complexity of Ordnance matériel, the maintenance problem is becoming increasingly difficult. This is illustrated by the wider distribution of all types of mechanized vehicles and antiaircraft matériel which has taken place in the last few years. A recent survey discloses that additional and improved facilities at Army posts, costing over one million dollars, are needed to provide prompt and efficient service.

The maintenance of matériel in this category is presumably carried out by the enlisted men of Ordnance maintenance companies. Since, however, the grades and ratings available for Ordnance enlisted personnel are insufficient to attract and hold men of the necessary ability, particularly for the more elaborate functions, it is necessary to supplement these companies with a number of civilian Ordnance machinists.

As regards the maintenance of matériel stored at Ordnance depots, facilities are for the most part adequate. Practically all the work is performed by civilian mechanics, and it is at these depots and at the arsenals that major overhaul, major modification, and reconditioning are carried out.

To give you some idea of the funds involved in these activities, over $600,000 was expended last year to maintain in a serviceable operating condition the Ordnance matériel in the hands of troops. This amount did not include the pay of commissioned and enlisted personnel. Current surveillance of ammunition required $220,000. This activity is mainly for the purpose of determining the serviceability of various types of ammunition and has no relation to the program for reconditioning ammunition, for which there was spent last year $950,000.

The current inspection of other matériel in storage, necessary to keep informed of its condition and to determine whether reconditioning is necessary, cost $250,000. In the inspection and overhaul of matériel stored at the arsenals and depots, $730,000 was expended.

The principal storage and issue depots are Raritan Arsenal, N. J.; Augusta Arsenal, Ga.; Rock Island Arsenal, Ill.; San Antonio Arsenal, Tex.; Benicia Arsenal, Calif.; also the Ordnance sections of the general depots at Schenectady, N. Y.; New Cumberland, Pa., and Columbus, Ohio.

LARGE quantities of stores and materials also are held at the Aberdeen Reserve Depot, the Frankford Arsenal Reserve Depot, and the Erie Ordnance Depot. The activities at these three depots will be very largely reduced in time of war when the matériel stored thereat has been issued to our troops.

The principal ammunition storage depots are at Raritan Arsenal, Delaware Ordnance Depot, N. J.; Curtis Bay, near Baltimore; Nansemond, on the lower James; Charleston, S. C.; Savanna, Ill.; and Ogden, Utah, with some magazine capacity at San Antonio Arsenal, Benicia Arsenal, and Aberdeen Proving Ground.

At several of these ammunition depots we have small ammunition-reconditioning units, and it is contemplated at the outbreak of war to establish first-phase loading plants at these depots for the purpose of assembling the ammunition components now on hand and to bridge the gap until the new plants, to which I have previously referred as being necessary for the loading of the great bulk of ammunition required, can be built and put into operation.

Practically all the supplies of ordnance now in reserve storage are those remaining at the close of the World War. After the Armistice, immense quantities had to be taken care of, and these supplies usually were housed at the nearest available storage point, with but little thought given to strategic safety or proper geographical distribution to meet the future needs of the Army. At present, some progress, but not enough, is being made in correcting this situation.

With funds now available, mainly from appropriations

for the Public Works Administration and the Works Progress Administration, construction of additional ammunition storage capacity at Savanna, Ogden, and San Antonio Arsenals is under way. With the completion of this work, the situation as regards adequate storage of ammunition will be greatly improved, but there still will remain the problem of obtaining funds to cover the cost of transferring ammunition stocks to these depots.

The depots for the storage and issue of Ordnance equipment at Raritan, Augusta, Rock Island, San Antonio, and Benicia, are reasonably well located and sufficient in number for the prompt and efficient supply of the several geographical sections of the United States and overseas possessions, both in peace and on mobilization.

OUR peace-time system for the issue of Ordnance supplies to the military forces provides for direct dealings between the corps-area commander in the person of his Ordnance officer and the depot. Each corps-area Ordnance officer is posted through the medium of Ordnance Field Service Bulletins as to the depots from which he can obtain the Ordnance supplies required. Requisitions from posts and stations in his corps area are passed upon by him for correctness as to nomenclature and for conformity with authorized allowances. The requisition is then sent *direct* to the designated issue depot such as, for example, Rock Island Arsenal. Upon receipt of the requisition by the depot, the supplies are shipped direct to the originating post or station.

To avoid a multiplicity of requisitions and numerous small shipments, each *station* Ordnance officer is expected to anticipate the needs of his station. He is required to submit periodical requisitions so that he will have on hand the material to cover the needs of all organizations for which he is responsible. At Regular Army stations the Ordnance officer, in effect, operates a *distributing point*. In the National Guard a somewhat similar procedure is followed.

When the total stock of an item is insufficient to meet all current needs, it is placed on a "controlled" list and all requisitions for such an item must be submitted by corps-area Ordnance officers to the Office of the Chief of Ordnance, where the limited stocks available are distributed in accordance with the policies prepared by G-4 of the General Staff.

The system I have described applies primarily to Ordnance issues for maintenance or consumption. In initially equipping a newly organized unit, as for example, a new National Guard organization, the Chief of the National Guard Bureau requests, and the Ordnance Department issues the material in question, in such cases, without a formal requisition.

For parts needed for maintenance and for expendable supplies such as ammunition, corps areas operate under a credit system. Credits are based on established authorized allowances. In order that depot stocks may be replenished, depots are required periodically to submit reports to the Chief of Ordnance showing the status of stocks on hand and the quantities issued during the preceding period. These reports are accompanied by stock-replenishment requisitions for items which are getting low. Upon receipt of these requests or requisitions, Field Service of the Ordnance Office takes steps to make replenishment by transfers from other depots where available surpluses exist or otherwise by procurement requisition on the Industrial Service.

After initial equipment of the units, their further supply will be provided for by credits to corps-area and other commanders. War is devastating on equipment and supplies, and the demand for ordnance will be very great. It therefore will be necessary to exercise close supervision over the issues of such stocks as are available. This will mean that the credits will have to be limited as to quantity and restricted to short periods of time. The system of *mobilization supply* is intended to conform in all essential respects to the system of supply now in effect. We must strive to reduce the number of controlled items, that is, those in which a shortage exists, and we must do everything possible during transition from a peace to a war basis, to avoid changes in our established system. Any change in organization or procedure will serve to add to the confusion inherent to the outbreak of war.

When the theater of operations is determined, there will be transferred to branch and general depots in the zone of the interior, but near the theater of operations, the supplies for the maintenance of the ordnance equipment in the theater. The location of the depots and the movement of supplies will be governed by the strategic plans of the theater commander.

OUR shortage in war reserves of necessity will result in a shortage of certain types of equipment for such time as will be required to fabricate them, which time runs from eight to fifteen months, depending on the type of equipment. These shortages for the most part include new and improved types of equipment which have been developed since the World War.

Our efficiency in war would be increased greatly if we could manufacture and have available types of equipment which have been developed since the World War, even though we may have on hand what may be regarded as reasonably satisfactory substitutes.

Our position also would be greatly improved if our progress was greater in modernizing certain types of existing equipment; for example, high-speed adaptation to 155-mm. gun and howitzer matériel, and overhaul and reconditioning of war-time types of various railway mounts. In general, there is very much to be done which might be accomplished if funds were available.

I have done my best to tell you what the Ordnance problem is. I have described our plans of operation, both in peace and war. I have not attempted to gloss over anything with the idea of leaving you with an impression that all is well and that the Ordnance Department is entirely ready to render complete service. On the other hand, I have pointed out certain deficiencies which now exist. I have pointed out a number of conditions which can be greatly improved.

May I venture the proposition that the success of the Ordnance plan is just as much the concern of every American citizen as it is mine, in our common obligation to the nation to be prepared for war if war comes. For if the Ordnance plan fails, our individual efforts in our respective fields cannot succeed.

Will you not therefore give the Ordnance problem your serious study, and will you not resolve to give all possible aid to its successful solution? If, by working together, we can do these things, then the Ordnance Department can and will meet its national-defense obligations in time of war.

Manufacture of High-Speed Tanks

Many Industries Furnish the Component Parts

By Maj. J. K. Christmas*

THE tank was first conceived in 1914 by a small group of clear-sighted Englishmen, led by Winston Churchill, who felt that the awful burden of the modern infantry soldier could be eased and his job done better by the use of machinery. While war chariots had been known for centuries, only the then recently achieved practicability of the internal-combustion engine and the caterpillar tractor made the modern fighting tank a feasible idea. Of special interest to us is the fact that the caterpillar tractor is primarily the development of an American, Pliny E. Holt. Tanks originally were known as "land ships," the term "tanks" being used at first only to mislead enemy intelligence agents. Tanks were first employed in battle by the British on the Somme in August 1916. Inventors may be interested to know that the French Army, led by Colonel Estienne, also originated and developed a tank, but the British efforts bore fruit first.

By 1918, all armies on the Western Front were using tanks, although the tank had the same trouble breaking into good military society the steam war vessel had in breaking into navies and the airplane into both armies and navies. Lest it be concluded from this that military men alone are unduly conservative, let me quote what Lewis Mumford says in "Technics and Civilization": "Perhaps the most positive influence in the development of the machine has been that of the soldier; in back of it lies the long development of the primitive hunter." And to judge by his book, Mumford is no particular friend of the military. When the Armistice was signed, General Pershing had indorsed tanks to the extent that our Army had on order some 23,000 tanks of various sizes.

At this point let me state the mission of the tank, *in 1916 as today:* to transport our fire power and fighting men with reasonable safety to the enemy's position; to mechanize (or increase) the soldier's defense with armor as the firearm long and increasingly has mechanized his offensive ability. The mechanical locomotion or mobility provided in the tank is fundamental in order to carry the necessary armor, but this mechanical propulsion incidentally also makes possible a quantity of fire power and a maneuverability not available in muscle-propelled infantry. However, great speed is definitely neither essential nor desirable in a tank since the rough and uncertain nature of the battlefield definitely limits the speeds which can be used. The tank, *through its armor,* mechanically integrates into a balanced weapon the three elements of combat—fire power, mobility, and protection.

THE Armistice of 1918 virtually stopped tank development as armies and nations somewhat contently settled back to economy and the good old days. Again mainly in England, a few defiant and fresh spirits, such as Fuller and Hart, kept the idea of mechanized warfare alive by their vigorous writings. This movement was reënforced by the general feeling in all European countries that something must be done to conserve man power in future war. Soon all major armies began some tank development, and eventually hundreds of experimental vehicles, some of the most weird design, were built.

As the movement gathered impetus, fostered by the small wars always going on somewhere in the world, tanks improved so much *mechanically* that all industrialized nations now have tanks capable of long and reliable operation both on the road and on the battlefield. This development was, of course, closely allied to the great improvements in the automotive and allied industries. *Tactically,* the development has been so diverse that in the world today there are tanks in service weighing from 3 to 141 tons, with speeds from 5 to 50 miles an hour, armor ¼ to 2¼ inches thick, crews from 1 to 28 men, and guns from caliber .30 to 6 inches. Fig. 1 shows briefly our own more modest tank development through eighteen years.

The present *engineering* status of the tank is that all industrial nations can and are building tanks that are reliable mechanically, simple to operate, capable of movement under their own power with an army anywhere, well armored, heavily armed, and reasonably durable. Both the initial and the operating costs have come down markedly. More specifically, our own tanks, such as discussed here, can march many hundreds of miles over roads and off them at speeds up to 40 miles an hour with little mechanical trouble. In a recent maneuver, 88 such machines started and 88 returned under their own power from a 700-mile operation over roads and cross-country terrain of various conditions.

The present *tactical* status of the tank is, like that of the airplane, still a fine topic for discussion and often fiery debate. This is necessarily so for two reasons: (1) Only recently have tanks been available in such quantity and such quality that conclusive tactical problems could be solved in field maneuvers; (2) No large-scale war between industrial nations has occurred to give tanks a conclusive test tactically. Since many no doubt have read certain recent popular articles predicated on the failure (predicted by many) of small lightly armored tanks, or "tin-clads," employed in small numbers in Spain, let me present a bit of further data.

Table 1 shows the estimated tank strength of some major armies about a year ago. Today, many nations positively are known to be producing additional tanks, some by quantity-production methods. The published tactical doctrine of France is to make no major attacks without the support of tanks, used on a scale of 40 to 80 tanks per 1000 yards of front. And if tanks are of no avail, why incorporate twenty to thirty special, high-powered, expensive *antitank* cannon in each infantry division, as several foreign armies do? Finally, in judging the value of the tank from the current wars, we also must remember that where lives are cheap, industry backward, and the treasury low, there is but little incentive

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This article was presented as an address before the semiannual meeting of the American Society of Mechanical Engineers, St. Louis, Mo., 1938. It expresses the personal views of the author and does not represent official policy on the subject.

to use tanks. Even so, we know that tanks are being used to some extent in these wars.

THIS brief review of tank development would be incomplete without mention of "mechanization" from the economic standpoint. The term "mechanization" refers to the use of automotive *fighting* vehicles, principally tanks, and not to the "motorized" transport of men and supplies behind the battle line. It can be shown conclusively from our own expenditures, that entirely aside from the intangible and moral losses due to war casualties, men are, in war as in industry, the most expensive item on the ledger. A soldier must be trained, fed, housed, equipped, paid, hospitalized, and finally, he or his dependents pensioned, quite justly.

The initial cost of a light tank in quantity production is about equal to the grand total cost of *one* fighting soldier; as to their relative fighting power there are still some differences of opinion. Further, when a tank or other fighting machine becomes a casualty the account is definitely closed. Finally—the point often is being raised in current military literature—men of the Western nations will be reluctant again to use their bodies to do what a machine can do, just as modern man will not perform in peace the drudgery he formerly did in mill and mine. Mechanization means "being stingy with blood and lavish with steel."

Let us turn now to the manufacture of tanks. In our Army a new type of tank is developed by a definite procedure which is outlined in Fig. 3. This procedure definitely prevents the tank designer from indulging his individuality; he must meet the demand of the ultimate customer—the fighting man of the Infantry or Cavalry, both of which use tanks. Unlike most customers, this customer thinks not primarily of cost, but he does demand the maximum of performance and reliability.

The tank as a whole has no counterpart in industry—its nearest relative being the track-type commercial tractor. But whereas a 10-ton tractor has a 60-horsepower engine, goes 6 miles an hour and carries no load, a 10-ton tank has some 250 horsepower, can go 40 miles an hour, and carries a load of armor, guns, ammunition, and men amounting to 35 to 50 per cent of the 10 tons gross. The other major difference between tank and tractor manufacture is that the "turnover" or annual production of tanks is, in our Army, both small and very fluctuating. From 1920 to 1935 the United States built only 31 tanks—these were all development or pilot vehicles. Since then we have made new tanks to replace the World War 6-ton and Mark VIII models used by our tank units.

Each new tank design is based on, and is partly an outgrowth of, its predecessors. A tank is so complex a mechanism that the designer necessarily must synthesize, coördinate, and integrate the knowledge and ideas of many specialized industries: engines, transmissions, clutches, armor plate, rubber, machine guns, radio, commercial tractors, and automotive accessories. From these specialized industries, we have obtained and are obtaining fine coöperation, both formally and informally.

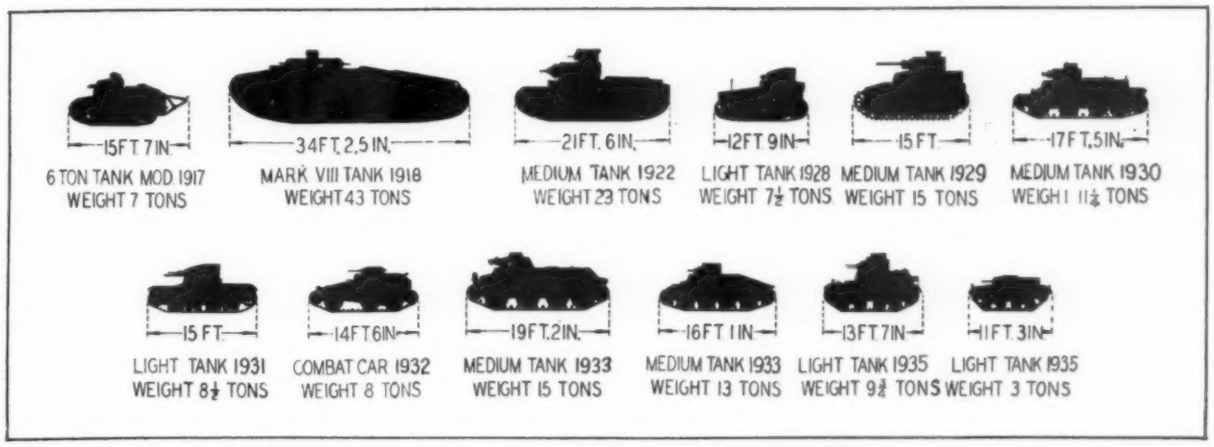


FIG. 1. COMPARATIVE SILHOUETTES OF PRINCIPAL AMERICAN TANKS, 1917-1935

A major instance of this coöperation is a large and representative standing committee, now over fifteen years old, of the Society of Automotive Engineers, which advises the Ordnance Department on its automotive problems through formal annual meetings. That committee recently had a 2-day meeting at Fort Knox, Ky., where our only mechanized cavalry brigade is now about completely equipped with modern vehicles, including many cavalry tanks or "combat cars." A Society of Automotive Engineers committee on rubber products met for two days in May at Aberdeen Proving Ground. In addition to the specialized industries mentioned, there are fields—such as high-speed tracks, suspensions, and tank steering—which have no civil interest and are the special province of the Ordnance engineer.

LET us now look briefly at the manufacture in limited production of a light tank which has been standardized or adopted by the War Department for use by our combat units. For this purpose a "light tank" of 10 tons gross weight has been selected; a late model of this tank is shown in Fig. 2. This tank was designed and developed as already indicated in Fig. 3. When the design was standardized and funds obtained from Congress, a definite order for about one hundred tanks was placed at Rock Island Arsenal, Illinois.

This tank is propelled by a 270-horsepower gasoline engine located in the rear; through a master clutch and a propeller shaft running through the fighting compartment, it connects to a 5-speed constant-mesh mechanical transmission. This, in turn, through a bevel gear and controlled differential, propels two cross shafts which, through reducing final

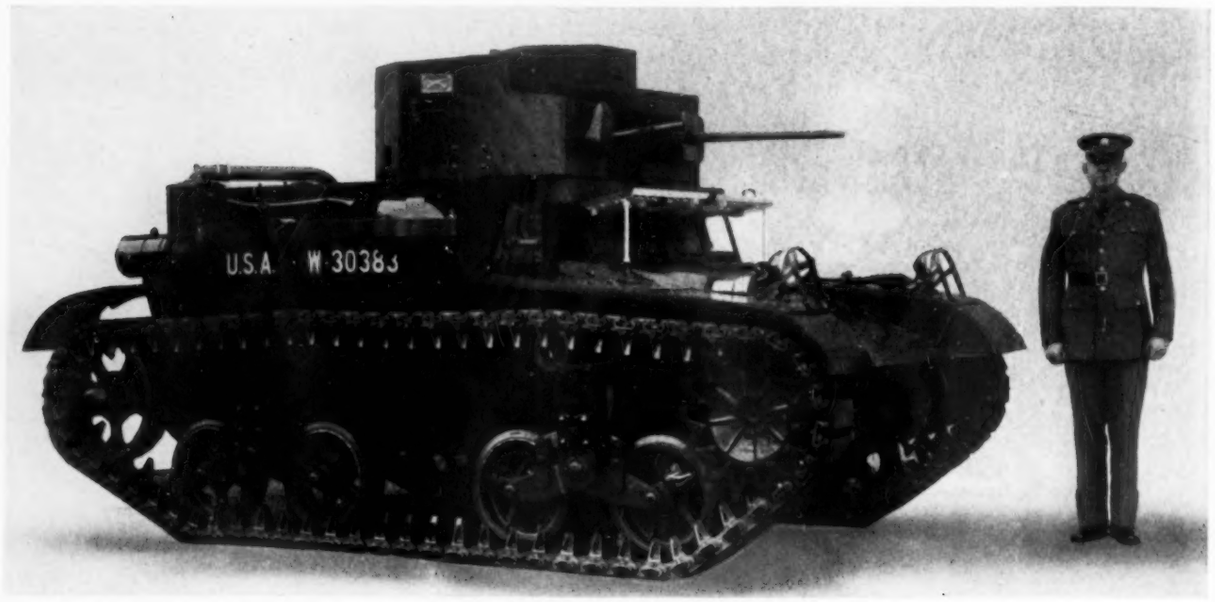


FIG. 2. THE ARMY'S LATEST IMPROVED LIGHT TANK

drives, propel the two track-driving sprockets on the sides of the tank at the front. Steering is accomplished by two variable brakes applied to the controlled differential to cause the two cross shafts to run at various differential speeds. The tank is suspended on four sets of 2-wheeled bogies, each individually carried on volute springs. The track consists of steel links to which a special rubber is vulcanized. These track shoes are assembled into an articulated continuous track by the use of rubber-bushed steel hinge pins and end connectors in such a way that no metallic friction occurs in the joints of the track. The wheels supporting the tank on the track are tired with solid rubber tires of a special design.

Having received an order from the Office of the Chief of Ordnance to build a definite number of light tanks, the arsenal's drafting room and engineering section must prepare all the detail working drawings, which amount to over 3200. These drawings show the dimensions, material, and heat treatment of each part, except that where a standard commercial article is called for, its trade name and commercial identification number are given. From these drawings the planning room prepares the bills of material, operation route sheets, and other manufacturing information for over 22,000 parts. However, in procuring the commercial type of parts, an additional step is required, not ordinarily necessary in private practice; namely, the preparation of a procurement specification. This is necessary because the laws of the United States, and the decisions of the courts and the Comptroller General corollary thereto, require that, except for experimental purposes, all procurement of supplies and material by the Government be by competitive bidding against specifications, and that the award be made to the lowest responsible bidder complying with the specifications.

The preparation of these specifications is in most cases one of the major problems in the manufacture of a tank because it is difficult to write a specification which is not restrictive as to the eligible bidders while at the same time insuring that the United States obtains a satisfactory article in every respect. Particular difficulty is had in the procurement of a complex manufactured article, such as an anti-friction bearing, where design, material, heat treatment, inspection, and the experience of the contractor all contribute to the final quality or performance of the article, and all these qualities are difficult to stipulate in a nonrestrictive specification.

The procurement is further complicated by the absence of any simple and generally recognized acceptance test as a criterion of quality. In order not unduly to control the design details of a commercial article and thus restrict bidding, resort is usually had to a performance test and a bonded guarantee of satisfactory service for a definite time or mileage.

THE principal items procured commercially are the engine and its accessories; all the armor plate, "fabricated" or machined ready for assembly; the 5-speed constant-mesh type mechanical transmission, and the rubber elements of the tank. For each of these major items an elaborate and detailed engineering specification is prepared (reënforced by necessary drawings) describing what is wanted, what it must do, how tested and accepted, and the guarantees involved. The procurement of such important items is controlled by a resident inspector at the successful bidder's plant. This resident inspector is a civil-service employee trained at the arsenal with respect to the special article which he is inspecting, and reporting to the arsenal commander through the Ordnance Procurement District in which the manufacturer's plant is located. After acceptance of the article at the manufacturer's plant, it is shipped to the arsenal where a final inspection takes place. In addition to an inspection as to the condition and completeness of the shipment, the final inspection varies with the nature of the article inspected. For example, in the case of transmissions, a final running-in, mechanical check, and noise test are made at the arsenal.

One of the most difficult items to procure is the armor plate. As an example of the items procured commercially, the manner of obtaining this important item will be discussed in more detail. Fig. 4 shows the general steps taken

in this procurement. The specification is a performance specification; that is, the contractor is required to furnish a plate of a certain thickness which will keep out our standard armor-piercing projectiles at certain velocities. He is thus perfectly free to use any composition, heat treatment, or other process he may wish, and has only to meet the firing test. This is conducted by the Ordnance Department, in his presence, at Aberdeen Proving Ground, Maryland. In addition, as an incentive to improve the plate, the contractor is paid a 5 per cent bonus for each 150 foot seconds that his plate is better than the specification.

The final criterion in the acceptance of the fabricated plate is whether it can be assembled into a complete tank hull at the arsenal. This system of final inspection has been found fairer to all concerned and less expensive than to make all the plates conform exactly to the toleranced drawings. It is of interest to note that the procurement of armor plate over a period of years has resulted in a marked increase in the quality and a marked decrease in the price of the plate, as both the steel industry and the Ordnance Department have learned from practical experience of procurement and manufacture how best to design and how to make the individual pieces. We are currently paying about eighty-three cents a pound for fabricated face-hardened armor plate as used in the light tank.

The manufacture of armor plate is a difficult matter and very much of a specialty. There is no doubt that in a time of national emergency the rapid procurement of large quantities of armor plate is the most difficult problem in the manufacture of tanks, and it is more than likely that in the interest of early production of tanks, some concessions in the quality of armor plate will have to be made initially.

In the manufacture of tanks, the highest grades of properly heat-treated material are used in order to increase fighting efficiency to the maximum; that is, by reducing the weight of all other components, a maximum may be devoted to armor plate and armament. Needless to say, the engine used in the tank is of the highest quality of materials and workmanship. In the rest of the tank, no cast iron is used, and steel castings, heat-treated, are used only where necessary. Some of these are armor-type castings of the highest quality obtainable. Aside from these, heat-treated alloy steels are used with special reference to resistance to shock and fatigue, although in some places (such as in the suspensions) surface hardening to resist wear is of greatest importance. Aluminum alloys are used, to save weight, for transmission cases, ammunition racks, and other interior fittings. Welding is used extensively, except on the armor plate. Where rivets cannot be used, self-locking nuts, lock washers and cotter pins are used to prevent loosening from the severe shocks and vibration to which the tank is subjected.

Certain other groups of components of the tank are manufactured at the arsenal; in this category are the metallic parts of the tracks, suspensions, clutch, flywheel and fan for the engine, turret traversing mechanisms, controls, gun mounts, ammunition racks, some machine guns, and many minor parts. For these items, the arsenal buys raw material

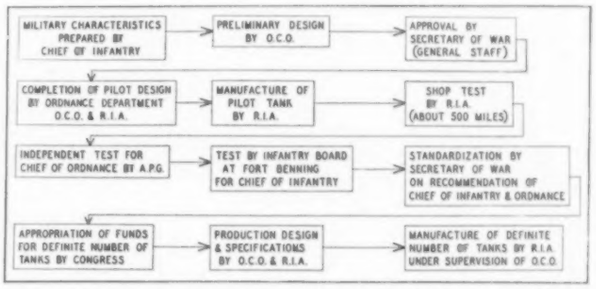

MILITARY CHARACTERISTICS PREPARED BY CHIEF OF INFANTRY
PRELIMINARY DESIGN BY O.C.O.
APPROVAL BY SECRETARY OF WAR (GENERAL STAFF)
COMPLETION OF PILOT DESIGN BY ORDNANCE DEPARTMENT O.C.O. & R.I.A.
MANUFACTURE OF PILOT TANK BY R.I.A.
SHOP TEST BY R.I.A. (ABOUT 500 MILES)
INDEPENDENT TEST FOR CHIEF OF ORDNANCE BY A.P.G.
TEST BY INFANTRY BOARD AT FORT BENNING FOR CHIEF OF INFANTRY
STANDARDIZATION BY SECRETARY OF WAR ON RECOMMENDATION OF CHIEF OF INFANTRY & ORDNANCE
APPROPRIATION OF FUNDS FOR DEFINITE NUMBER OF TANKS BY CONGRESS
PRODUCTION DESIGN & SPECIFICATIONS BY O.C.O. & R.I.A.
MANUFACTURE OF DEFINITE NUMBER OF TANKS BY R.I.A. UNDER SUPERVISION OF O.C.O.

FIG. 3. MAJOR STEPS IN PRODUCING A U. S. FIGHTING TANK

(*Legend:* O.C.O.—Office, Chief of Ordnance; R.I.A.—Rock Island Arsenal; A.P.G.—Aberdeen Proving Ground.)

to specifications from the private industries and performs the manufacturing operations in the arsenal in conformity with the detail drawings. For this class of material, an elaborate and varied inspection system operates within the arsenal directly under the commanding officer and *not* under the control of that part of the arsenal responsible for manufacture. The arsenal commander thus has a wholly independent check on the operations of his manufacturing division.

The arsenal's planning room schedules the work in the arsenal's shops and the deliveries of the components from private sources in such a way that there will be available in the manufacturing stores at the arsenal all the parts necessary to assemble tanks in the assembling section.

THE assembly operation starts with the assembly of the hull or chassis of the tank, composed wholly of armor plate. These hulls are assembled progressively on a series of horses in one wing of the arsenal, the plates being assembled by riveting in place carbon steel angles and butt straps. The holes in these are located by using the armor plates as jigs.

The next operation is the installation of the transmission in the forward end of the vehicle at the same time that the engine with its fan, flywheel and clutch is being installed in the engine compartment at the rear of the vehicle. Prior to the installation of the engine, the assembly, consisting of the fan, flywheel and clutch, has been statically and dynamically balanced at the arsenal before assembly on the engine crankshaft. The steel track links are brazed together automatically at the arsenal, then shipped to a rubber company

Nation	*Standing Army*	*Air Force*	*Trained Reserve*	*Maximum Military Man Power*	*Airplanes*	*Tanks*	*Navy Tonnage*
British Empire	390,291	46,600	632,053	18,000,000	4,000	750	1,232,800
France	708,000	34,350	5,500,000	8,000,000	3,000	3,000	546,000
Russia	1,500,000	50,000	19,450,000	32,000,000	4,700	3,500	200,000
Germany	650,000	80,000	1,850,000	13,000,000	3,000	2,300	300,000
Italy	1,111,593	201,300	5,214,368	8,000,000	3,200	2,000	529,000
Japan	280,000	15,000	2,000,000	18,000,000	2,000	800	754,000

Command and General Staff School Quarterly

TABLE 1. ESTIMATED MILITARY STRENGTH OF FOREIGN POWERS

to have the rubber pads vulcanized to them. On return of the shoes, these are assembled at Rock Island Arsenal with rubber-bushed pins into a continuous track. After assembly, the tank is given a 75-mile operation on the arsenal reservation under its own power as a shop test prior to its final inspection and shipment.

THE specially difficult components of the tank from a procurement standpoint, both in peace and war, are the armor plate, the engines, the transmissions, and the rubber components. This is because these components require very specialized knowledge and experience on the part of the manufacturer and special facilities—which facilities are distinctly limited. Even when the industries are not busy or prosperous, although these components are procured by wide circular advertising, very few acceptable bids are obtained (and very few unacceptable ones also).

Even as it is, some of the contractors who now bid on or have furnished the above components, may be said virtually to have set up a special activity for furnishing these components to the Ordnance Department, as there is practically no civil market for such equipment. Since the annual requirements of the Army, measured by industrial standards, are small and necessarily fluctuate from year to year with the appropriations received, many firms will not interest themselves in doing such highly specialized work. This is one of the primary reasons that tanks as a whole (as well as some other items of Ordnance equipment) are basically manufactured in our arsenals in such a way that all those components which can be economically and promptly obtained from private sources may be put out for private procurement at any time.

The remaining components then are made and the assembly done at the arsenal. The components which can be so obtained vary from time to time with the state of business, the size of the order, and the type of equipment to be procured. In this respect we are at a distinct disadvantage as compared with other industrial nations which have a private munitions industry continuously engaged in the manufacture of armament. This situation has an important bearing both on peace-time and war-time production of tanks and other items of Ordnance. A fairly uniform annual program of tank manufacture would help enormously both as to development and costs of manufacture.

Component or Group	*Actual Weights of Components (Lbs.)*	*Per Cent of Total Weight*
Hull (armor plate)	6,277	32.40
Engine and accessories	1,054	5.45
Transmission (incl. clutch)	1,261	6.50
Final drive	1,263	6.50
Tracks	2,500	12.90
Suspension	3,012	15.50
Fuel and tanks	467	2.40
Armament	299	1.55
Ammunition	767	3.95
Crew and packs	800	4.10
Radio	116	0.60
Accessories and misc.	1,584	8.15
Total:	19,400	100.00

TABLE 2. MAJOR COMPONENTS OF THE LIGHT TANK

This paper would be incomplete without some discussion of costs. Without going into details, it can be stated that the costs of our tanks, produced as they now are in very limited quantity, are reasonable. The cost amounts to about $1 per pound without armament, and about $1.25 per pound if the armament be included. While this may appear very high compared to the cost per pound of cheap motor cars, this is not a fair comparison. A fair comparison would be with high-grade automobiles, machine tools, electric equipment, and airplanes. Table 2 shows the percentage by weight of the various major components in relation to the tank as a whole, from which an idea of the relative amounts of costs involved in the various subassemblies can be obtained.

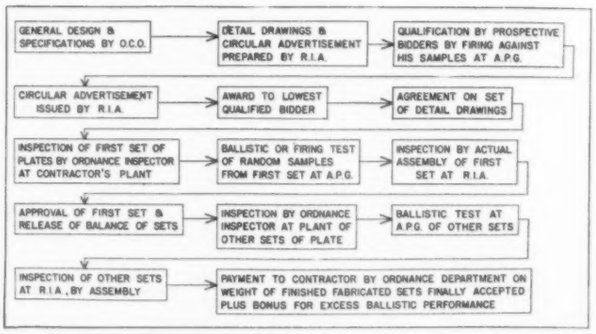

GENERAL DESIGN & SPECIFICATIONS BY O.C.O.
DETAIL DRAWINGS & CIRCULAR ADVERTISEMENT PREPARED BY R.I.A.
QUALIFICATION BY PROSPECTIVE BIDDERS BY FIRING AGAINST HIS SAMPLES AT A.P.G.
CIRCULAR ADVERTISEMENT ISSUED BY R.I.A.
AWARD TO LOWEST QUALIFIED BIDDER
AGREEMENT ON SET OF DETAIL DRAWINGS
INSPECTION OF FIRST SET OF PLATES BY ORDNANCE INSPECTOR AT CONTRACTOR'S PLANT
BALLISTIC OR FIRING TEST OF RANDOM SAMPLES FROM FIRST SET AT A.P.G.
INSPECTION BY ACTUAL ASSEMBLY OF FIRST SET AT R.I.A.
APPROVAL OF FIRST SET & RELEASE OF BALANCE OF SETS
INSPECTION BY ORDNANCE INSPECTOR AT PLANT OF OTHER SETS OF PLATE
BALLISTIC TEST AT A.P.G. OF OTHER SETS
INSPECTION OF OTHER SETS AT R.I.A., BY ASSEMBLY
PAYMENT TO CONTRACTOR BY ORDNANCE DEPARTMENT ON WEIGHT OF FINISHED FABRICATED SETS FINALLY ACCEPTED PLUS BONUS FOR EXCESS BALLISTIC PERFORMANCE

FIG. 4. PROCUREMENT OF TANK ARMOR PLATE BY ORDNANCE DEPARTMENT, U. S. ARMY

(*Legend:* O.C.O.—Office, Chief of Ordnance; R.I.A.—Rock Island Arsenal; A.P.G.—Aberdeen Proving Ground.)

Your attention also is invited to the wide range of industries involved in the production of a tank; that is, the primary industries only, without going back to the semi-finished-component and the raw-material industries behind all these. The following industries contribute to the construction of a tank: steel, engine, automotive parts (transmission), automotive accessories, airplane accessories, rubber, antifriction bearings, electrical, aluminum, and radio. The raw material principally involved is, of course, steel, with rubber a close second in its relative importance to the success of the tank, but not in the quantity used.

Concluding this article, in which I have endeavored to give a brief survey of the status of our national defense with respect to one major weapon of modern mechanical warfare, I should like to leave with you these concrete ideas: 1. The tank is a major weapon of modern machine warfare like the airplane or the fighting ship. 2. Our tanks now are designed by the Ordnance Department and assembled at Rock Island Arsenal from components manufactured mostly by private firms. 3. Being a complex weapon representing the integrated efforts of many industries, it will be difficult and slow to get into quantity production. 4. Large numbers of tanks will be needed, and their losses may be expected to be high, but losses in tanks probably will, to a very large extent, replace losses in man power. 5. The tank is still comparatively new, and much additional development, including the building of much larger tanks, reasonably may be expected. 6. Technically, the tanks of our Army are equal, and in some respects superior, to any other tanks in the world. 7. And last, but not least, whenever it tactically can take the place of fighting men, the tank costs less to use than men, even disregarding the intangible losses to the nation when its young men are killed and wounded.

Small-Arms Ammunition

Manufacturing Processes Used at the Frankford Arsenal

By Lieut. Col. R. H. Hannum*

THE purpose of this article is to give the average layman some idea of the care and the amount of work required to manufacture ammunition for rifles and machine guns. The same processes are in use, generally, as in other plants in the United States and abroad engaged in the manufacture of ammunition for military or sporting rifles. Every year, approximately one thousand people visit the Government's small-arms ammunition plant. While it is true that a great many of the visitors are cadets of the Military Academy, R.O.T.C. students, and Reserve officers in camps in the vicinity of Philadelphia, a goodly number of interested American civilians are among the visitors. These, on numerous occasions, have expressed their amazement at the amount of work involved, the care exercised, and the number of automatic or semi-automatic machines used in the manufacture of small-arms ammunition at Frankford Arsenal.

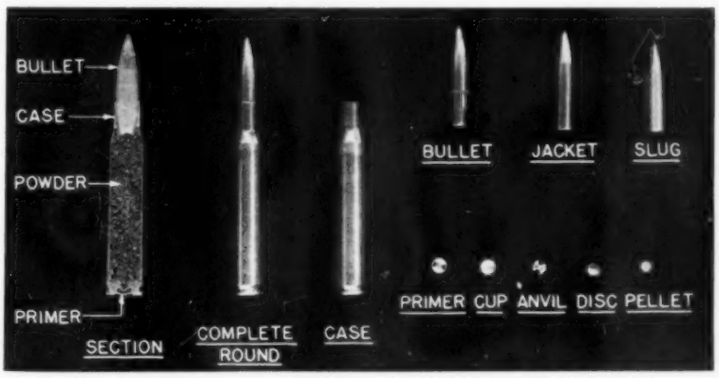


FIG. 1. COMPONENTS OF SERVICE AMMUNITION, CAL. .30, M1

Frankford Arsenal is 124 years old, having been established at Bridesburg, in the northeastern part of Philadelphia, in 1814. At first a supply and storage depot, it gradually developed into a manufacturing arsenal, until at the present time it has become one of the largest Government arsenals in the country. One of its important items of manufacture since 1845 has been small-arms ammunition, or ammunition for pistols, rifles, and machine guns. Ammunition of Frankford Arsenal manufacture is known throughout the world, and we can justly be proud of its reputation for accuracy.

At the present time, Frankford Arsenal manufactures small-arms ammunition of three calibers. In passing, it might be well to define the word "caliber." It is the diameter in inches of the bore of the weapon in which the ammunition is used. These three calibers are as follows: (1) Caliber .45 ammunition, used in caliber .45 automatic pistols, caliber .45 revolvers, and in the Thompson submachine gun; (2) Caliber .30 ammunition, used in rifles, automatic rifles, and machine guns; (3) Caliber .50 ammunition, used in machine guns only.

The latter two classes are divided still further into a number of types, the most important of which are ball, armor-piercing, and tracer ammunition. These are alike except for the bullet. The bullet for ball ammunition contains a lead slug or a soft steel core, while the bullet for armor-piercing ammunition contains a hardened steel core which is designed to pierce armor plate. The bullet of tracer ammunition is filled with a chemical composition which is ignited by the explosion of the powder of the propelling charge. This chemical composition burns with a bright red flame and thus traces the flight of the bullet through the air from gun to target, aiding the shooter to direct his fire.

Let us now examine a round of ammunition to see of what it is composed. First of all, the components of a cartridge are the primer, the powder charge, the cartridge case, and the bullet. In turn, the primer is composed of the primer cup, the primer pellet—which is an explosive composition—the foiling disk, and the anvil. The powder charge is usually a nitrocellulose powder such as is manufactured commercially. The bullet is composed of a gilding-metal jacket and a lead slug or a steel core. In the case of a tracer bullet, the jacket contains a small lead slug or point, behind which is tightly packed the tracer composition to fill the jacket. The assembly of the above three components in the cartridge case makes a complete cartridge (Fig. 1).

WE NOW are ready to describe, in as simple terms as possible, the steps in the manufacture of a round of ammunition. The fabrication of the major components of a cartridge is considerably more involved than the average layman imagines, and requires extreme care to insure a finished product which will meet the extremely close tolerances allowed and the rigid requirements of Ordnance Department specifications.

For sake of convenience, the description of caliber .30 ammunition will be given. Caliber .50 and caliber .45 ammunition are manufactured in a similar manner except as to the number of operations required.

A caliber .30 cartridge with gilding-metal-jacketed lead-slug bullet is known as "service ammunition," and its proper and official nomenclature is "cartridge, ball, caliber .30, M1." This ammunition requires a total of 111 operations from the time the raw materials are received until the ammunition is packed ready for shipment. The operations are roughly divided into 64 mechanical operations, 7 annealing operations, 5 pickling operations, 19 washing operations, and 16 drying operations.

In addition to these operations, there are, throughout the process of manufacture, continuous inspection and gaging, and on the completed round, one hundred per cent me-

*Office of the Chief of Ordnance. Lieutenant Colonel, Ordnance Department, U. S. Army.

chanical gaging besides visual inspection and proof firing.

The case is started from a flat strip of what is known commercially as "cartridge brass,"—an alloy containing approximately seventy per cent copper and thirty per cent zinc. This brass must be free from flaws and must be uniform in thickness and temper. The first operation is called "blanking and cupping," and is done on what is known as a "double-action" press. The cupping punch works in the interior of the blanking punch and the die used is a double one, the upper portion cutting the disk and the lower portion forming the cup. The disk, after being cut or blanked by the blanking punch, remains in the upper portion of the die, and while so positioned, is pressed down by the cupping punch through the lower or cupping part of the die, and thus the cup is formed.

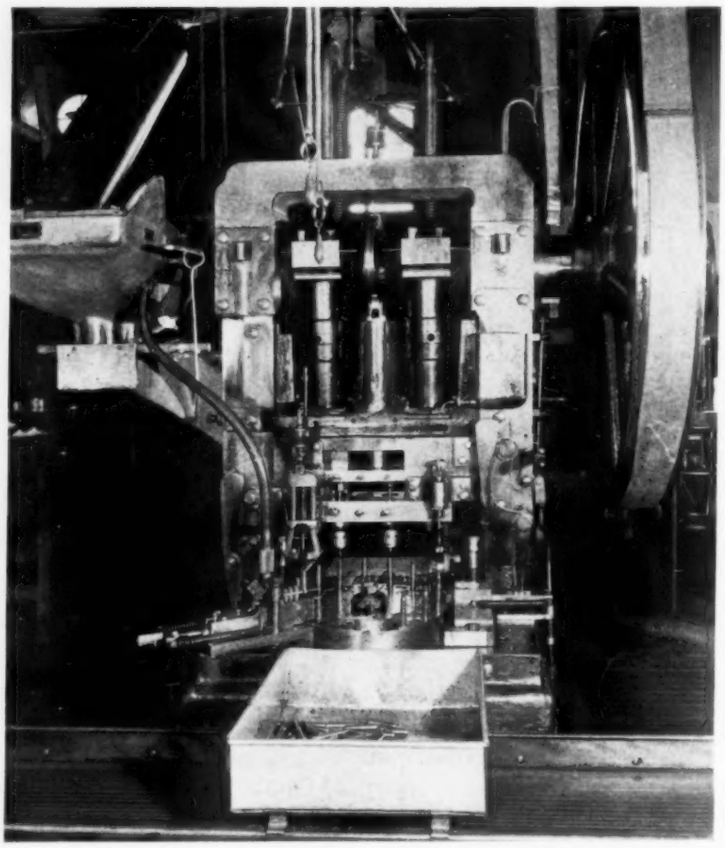


FIG. 2. CALIBER .30 AMMUNITION TAPERING MACHINE

AFTER the cupping operation come the five drawing operations in which the diameter and wall thickness are reduced successively to a tube closed at one end, approximately three inches in length and one-half inch in diameter. These five operations are done by draw presses equipped with appropriate punches and dies to give the proper reduction in diameter and wall thickness. These machines are hopper-fed; that is, the draw pieces are put into an attachment to the machine called a "pin-wheel hopper," which has a wheel with pins around its circumference. These pins engage in the tubular draw pieces at the bottom of the hopper and deliver them to a tube or chute which leads to an opening over the die in the draw press. All the work is delivered in the same position—with the closed end of the tube down. The operator, therefore, has only to watch his machine for bad work, broken dies or punches, and to see that the hopper is feeding pieces properly.

Before the fourth draw, there is a bumping operation which is done on a machine similar to the draw press. The purpose of this operation is to work the metal in the head of the case so that it becomes harder and shaped for subsequent operations. As the drawing operations progress, the tube of metal becomes longer and longer, and the metal at the open end of the tube goes to a feather edge and becomes very irregular. It therefore is necessary to cut off this irregular surface. This is done on a special machine, and the operation is called a trimming operation; it takes place after the fourth draw for the purpose of facilitating the feeding in the fifth draw, and again after the fifth draw to have the case in the proper shape for the subsequent operations of pocketing and heading.

A casual study of the number of operations on the case might suggest to the layman that all that is necessary to manufacture a cartridge case would be to have a battery of machines and run each operation successively. This cannot be done, however, as cupping and the successive drawing operations on the case work the metal and it becomes hard and brittle so that after each draw it becomes necessary to soften it sufficiently to allow it to be drawn properly in the succeeding operation. This softening is called annealing, and at Frankford Arsenal annealing is done in a rotary-type furnace, heated by electricity for a sufficient time and at a predetermined temperature, so that the desired softness of the metal again is obtained. The time and temperature of each anneal is controlled by automatic means so that all work is uniform in softness. In this operation an oxide film is deposited in the surface of the cases. This must be removed, or the punches and dies on the drawing presses would be ruined in a very short time. The work, after being annealed, is washed in tanks containing a solution of three per cent sulphuric acid; after that the work is washed with water to remove all traces of acid and rumbled until almost dry.

After the drawing, trimming, and annealing operations come the pocketing and heading operations. In the first, the head of the case is worked by means of a punch, and a pocket is formed which later becomes the seat for the primer. In the second, the pocket is further formed to correct size, and the head of the case is flattened and formed. Also in this operation, the head of the case is stamped with the caliber of the ammunition, the initials of Frankford Arsenal, and the year of manufacture. The marking is, therefore, in this instance, "Cal. .30—F.A.-38". This aids in identifying ammunition when it is used later.

THE next operation is that of head turning. Here the excess metal in the head is turned off in a machine much like a small lathe. At the same time and with the same tool a groove is cut in the head of the case. This groove is called an extractor groove, and it is the means of extracting the fired case from the chamber of the weapon. The case now

has a head turned to the proper diameter and a groove for extracting. These dimensions are very important and are controlled accurately at all times to insure proper functioning of the ammunition in rifles and machine guns.

The upper part of the case now is given an anneal in an open gas flame. This anneal extends about half-way between the mouth and the head, and softens that portion of the case so that it will not fold, crease, or break in the necking or tapering operation. The tapering operation forms the neck of the case by drawing in or tapering the metal and giving it a shape similar to the neck of a bottle. This is done in two steps by means of dies. The first step is called a preliminary or first taper, and the second, the final taper (Fig. 2). After this, the mouth of the case is trimmed to its final length. The mouth of the case then is given another anneal in an open gas flame. The purpose of this anneal is to soften the metal at the mouth and to prevent season cracking of the completed ammunition in long storage.

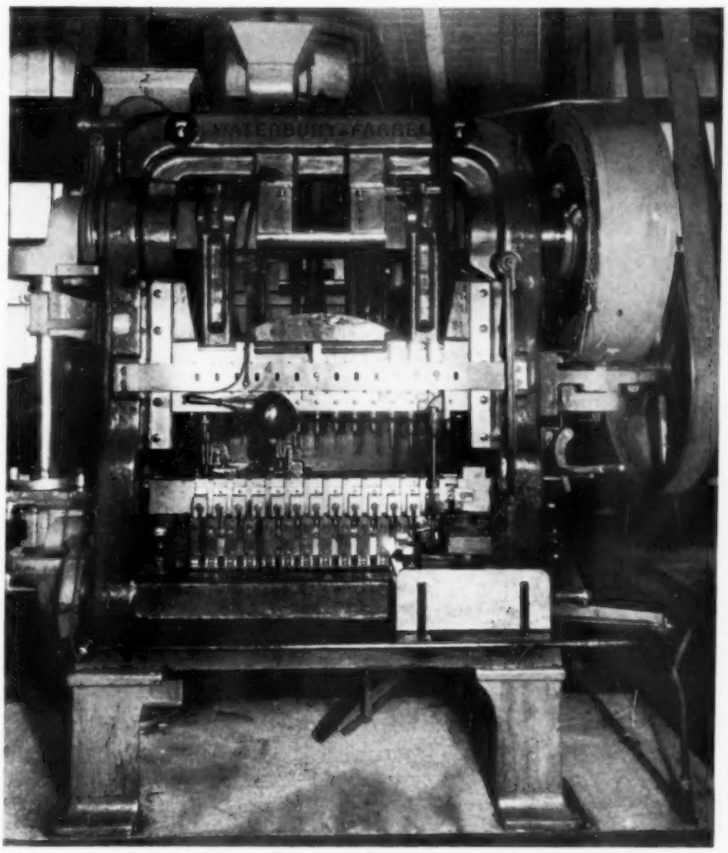


FIG. 3. FIFTEEN-STATION STRAIGHT-LINE BULLET ASSEMBLY MACHINE

The case now is almost completed except for venting, priming, and waterproofing around the primer and inside the mouth of the case. These operations are performed on a single machine which is entirely automatic. The vent is a small hole that is punched through the bottom of the pocket in the head of the case, and it is the means by which the flame from the fired primer reaches and ignites the powder of the propelling charge. After venting, the primer is inserted into the pocket, pressed into place, and then crimped in the pocket by a flash of metal thrown up and pressed around the top of the pocket by a punch. In order to prevent moisture from entering the completed round of ammunition, a drop of waterproofing compound is placed around the head of the primer and on the inside of the mouth of the case. This machine is one of the most interesting used in the manufacture of ammunition for it is automatically fed and automatically stopped if a case has failed to receive its vent or primer, or if foreign material is contained in the primer pocket or inside the case (Fig. 4).

Having described the manufacture of the complete case, let us now describe the manufacture of the primer, which is the most important component of ammunition—the heart of the cartridge. If the primer fails to fire, the propelling charge is not ignited and the bullet never leaves the case. In other words, the cartridge is dead, no matter how good the powder and metallic components are. As was stated before, the primer is composed of the primer cup, the primer anvil, and the primer composition or pellet covered by a disk of paper. The anvil is made on a small double-action press in the same manner as the primer cup. Being a very small article, its dimensions must be and are controlled very carefully.

THE first operation is making the cup, which is made exactly as described above for the blanking and cupping operation for the cartridge-case cup. However, the machine, although similar in design, is very much smaller. It is extremely important that the strip cartridge brass be uniform in thickness and temper so that there will be as little variation as possible in the height of the cup. In other words, a very close tolerance must be maintained.

The primer mixture, consisting of four chemicals, naturally is of an explosive nature and is made in a separate building far from the manufacturing plant, with due care that all safety precautions are taken both as to workers and property. The chemicals are mixed by hand on a special table of glass resting in a tank of water. The mixture is prepared wet and, in that condition, is sent to the primer shop where it is rubbed into a plate which contains rows of holes of a size to make the proper amount of the priming mixture into a pellet. A constant check is maintained to insure that the pellet is of the proper weight. This plate with the pellets then is placed over a similar plate, the holes of which previously have been filled with the primer cups. The pellets then are transferred to the cups by a series of punches corresponding to the holes in the plate. Then the plate holding the cups containing the pellets is transferred to a machine equipped with properly indexed punches which cut small disks of shellacked paper, called foiling disks, which are pressed over the corresponding pellets, and at the same time the pellets are compressed to the desired thickness. The foiling disk prevents the mixture from falling out during subsequent operations and also tends to keep moisture from the primer composition. The cups with pellets and foiling disks in place are taken out of the plate and transferred to another similar but smaller plate. Over this plate is placed another, the holes of which contain the anvils and index with the primer cups. These plates are clamped together and

in turn are placed under a hand press and the anvils are pressed out and into the primer cup to the proper depth. The primers are taken out of the plates and dried thoroughly at a constant temperature where the mixture now becomes a solid mass. After drying, the primers are kept in a dry house until ready to be inserted into cartridge cases. As each lot of primers is made, a representative sample is taken and drop-tested on a machine which simulates the action that takes place in a weapon when the firing pin strikes.

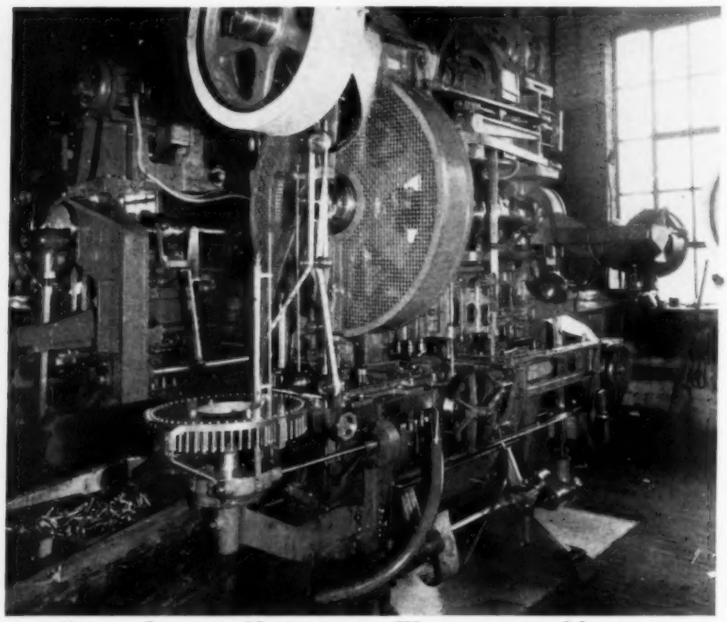


FIG. 4. PRIMING, VENTING, AND WATERPROOFING MACHINE

It may be interesting to know how a primer is fired. When the firing pin of the weapon strikes the primer cup, the mixture between the bottom of the primer cup and the point of the anvil is suddenly squeezed with sufficient force to generate enough heat to explode a few crystals of explosive. The flame thus produced ignites the remainder of the mixture and passes through the vent of the case and thence to the propelling charge which in turn is ignited.

Having described the manufacture of the case and the primer, let us proceed with the description of the manufacture of the bullet.

The caliber .30 bullet is composed of a gilding-metal jacket and a lead slug. Let us now follow through the operations of making these components (Fig. 1). The gilding metal, of which the jacket is made, is an alloy composed of ninety per cent copper and ten per cent zinc, and is very much softer than cartridge brass. This metal is used because very few flakes are deposited in the bore of the weapon as the bullet passes through it. In the words of a rifle shooter, gilding metal produces very little "metal fouling" in the bore of the rifle.

Blanking, cupping, drawing, and trimming are done exactly as described for these operations in the manufacture of the cartridge case, except that the number of draws is only four, and no annealing of the metal during this processing is required. The machines used in these operations are again quite similar, but much smaller. Here we end up with a tube closed at one end, about one inch in length and approximately 0.3 of an inch in diameter.

THE manufacture of the lead slug is a little more complicated. An ingot of lead-antimony alloy is placed in a die in the bottom of a hydraulic press. This die has in its bottom a hole of the proper diameter for the lead wire which is to be extruded, and pressure on the ingot by a ram forces or extrudes the metal through this hole and it comes out in the form of lead wire of the diameter desired for the next operation. This wire is very hot as it comes from the press, and it passes through a trough of water before being automatically wound on a reel. The reels are transferred to swaging machines, into which the lead wire is fed. This machine cuts off the proper length of wire and then swages it into its proper length, shape, and weight, to form the lead slug. The slugs then are rumbled with rags to remove burs, fins, and oil.

The assembly of the bullet is performed on a 15-station straight-line bullet machine. The jacket and lead slug are automatically fed to this machine and the assembly transferred from one station to another by means of a slotted sliding bar. The pointing of the jacket to form the ogive of the bullet, the insertion of the lead slug, the boat-tailing of the base of the bullet, the sizing of the bullet, the canneluring and resizing of the bullet are performed on this machine. As the bullet leaves the fifteenth station it is complete and, after inspection, ready for assembly into ammunition. This is another very interesting machine used in the manufacture of ammunition, and is shown in Fig. 3.

The manufacture of the components of a cartridge is now completed. There remains to say a word about the powder. For the caliber .30 cartridge, a smokeless nitrocellulose powder is bought on contract from commercial powder companies. This has met the rigid tests required for acceptance before being used for loading the ammunition. The powder for caliber .30 ammunition is usually I.M.R. No. 1185. "I.M.R." means "Improved Military Rifle." This powder is made in lots of 50,000 pounds each. Powder lots vary so slightly ballistically from each other that it would be considered safe to mix them. However, a rigid rule, long established, is always carried out at Frankford Arsenal. This rule is that no ammunition lot will contain more than one lot of powder.

ON the loading machine, the bullet, the primed case, and the propellent powder charge are brought together to make the complete cartridge. The cases, set mouth up by hand on a revolving dial plate, are carried to, and transferred under, the funnel openings in the case head of the machine, in which position they pass under the charging block. This block contains an adjustable hole and is directly under the tube from the magazine holding the powder. The movement of the block is synchronized with the movement of the case head. When retracted, the hole in it is under the powder magazine, and it is filled or charged by gravity. The block then advances until the hole containing the powder charge is over the funnel of the case head, when the powder drops through this funnel into the cartridge case.

Notice that at Frankford Arsenal the charge is measured by volume, but constant check is made on a delicate balance

to keep the weight of that volume of powder equal to the predetermined weight of the charge. Should a variation of three-tenths of a grain be detected in the weight of the charge, the volume of the charging block is corrected accordingly. Whenever a correction is made, a recheck of the charge is taken and weighed before the machine is put in operation. In the case of special ammunition, such as National Match, this check is made every half hour.

After the case has received its charge of powder, it is transferred automatically to a hole in another dial plate, into which the bullets are fed automatically so that each bullet enters a hole in the dial plate base down. The bullet is pressed by a punch to the proper depth into the charged case under it. The cartridge is now transferred automatically to a third dial, or crimping head, where rollers crimp the mouth of the case onto the bullet. This completes the cartridge, but throughout its manufacture, very thorough inspection is maintained. This takes the form of a process inspection and a component inspection.

The general principle of process inspection is to discover, correct, and eliminate defects occurring during manufacture. It is essential to insure that any faulty process, tool, or machine is located, and the fault corrected to eliminate defective components. It thus helps to prevent scrap loss, and to insure the manufacturer that his product will meet the rigid specified requirements.

Component inspection is essential to eliminate defects in either the primer, bullet, or cartridge case, which, if present in the completed round, would cause the rejection of that round. These inspections are made before the components reach the loading machine, and therefore eliminate at least what would be the greater portion of completed defective ammunition, and aid in reducing the final cost of ammunition.

As the ammunition leaves the loading room it is divided into lots by which it is identified until it eventually is fired. These lots are sent to gaging machines in which each cartridge is automatically gaged for over-all length, body length, large body, head thickness, head diameter, and depth of primer. Any cartridge that fails to meet this gaging is rejected automatically by the machine according to its defect (Fig. 5).

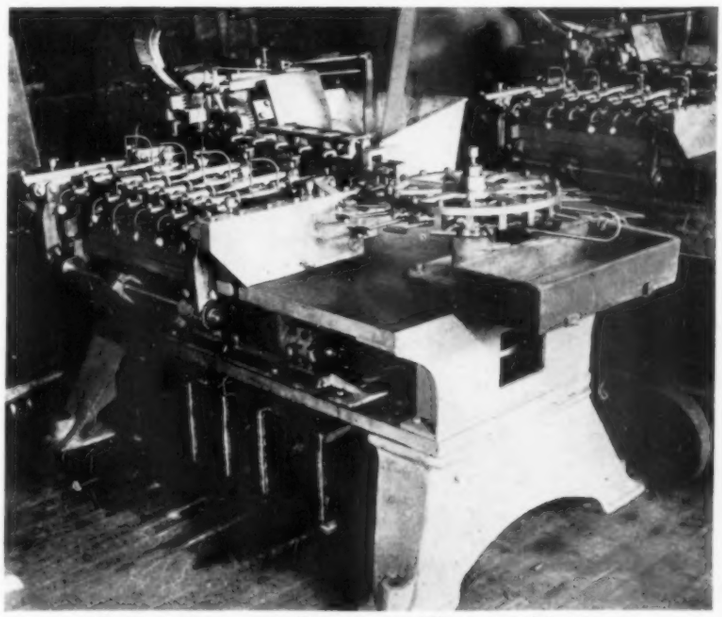


FIG. 5. CARTRIDGE GAGING AND WEIGHING MACHINE

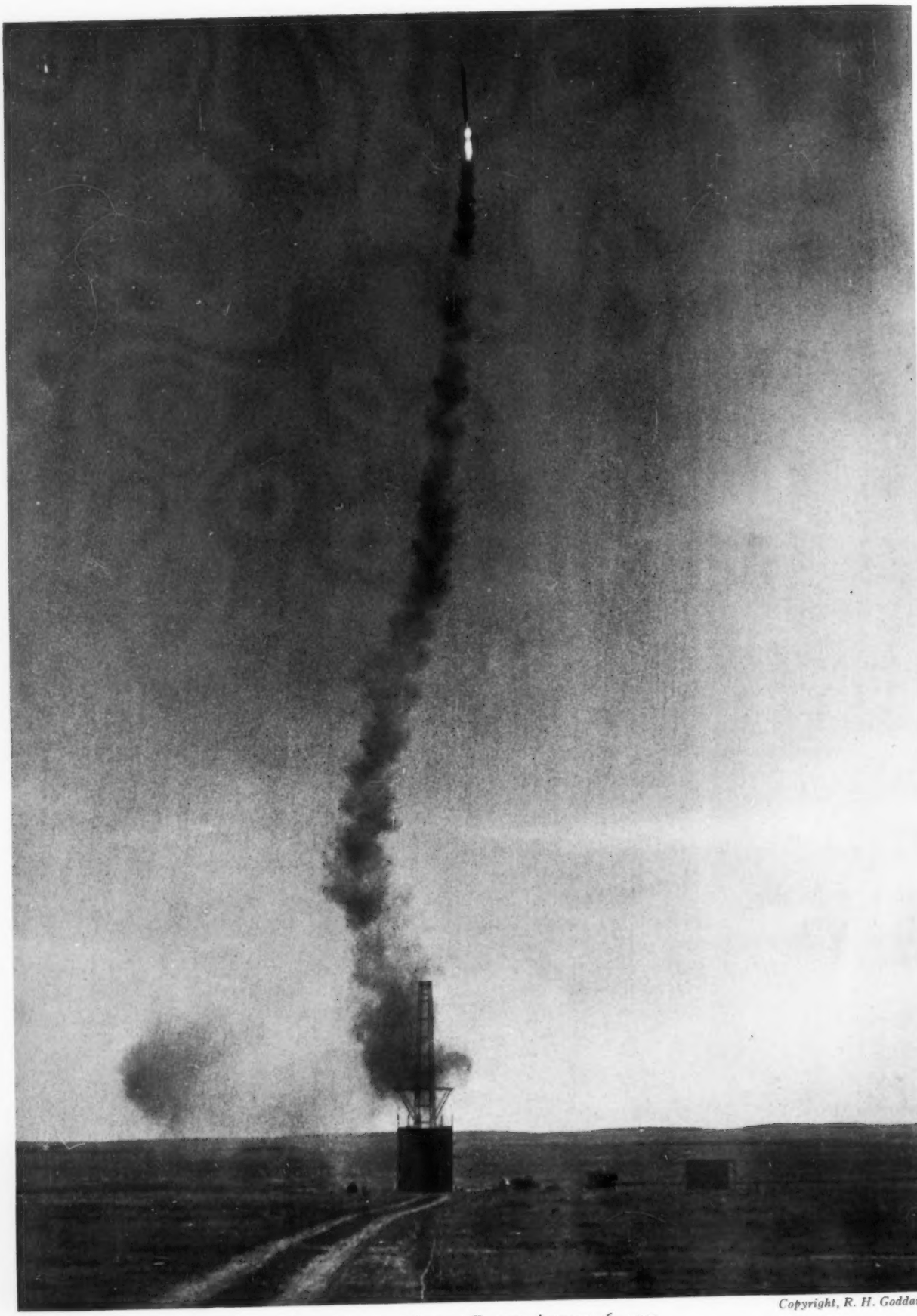
NOW comes the final test, called the acceptance test, by which a lot of ammunition stands or falls, or is accepted or rejected. This test is made by selecting from the completed lot of ammunition a certain percentage as a sample. For example, in a lot consisting of 500,000 rounds, 1.5 per cent, or 7500 are selected at random. Every cartridge of this sample is gaged and visually inspected for defects, and, in addition, approximately 2000 rounds actually are fired to determine whether the accuracy, velocity, and pressure are within the prescribed limits. Also, the above firing is made to prove that the ammunition is assembled properly and functions properly in the various types of standard machine guns, automatic rifles, and rifles without producing hangfires and misfires. In all functioning, the fired case must extract easily from the weapon.

These results, determined by the above, must meet the requirements of the governing specification, which are indeed rigid. For instance, the velocity of the ammunition must be between 2570 and 2630 feet per second at 78 feet from the muzzle of the weapon. That means the bullet leaves the muzzle at a higher speed. This speed can be illustrated best by saying that the fastest man has traveled through the air in an airplane is 440 miles an hour, or 645 feet a second. Yet a service bullet, with an initial velocity of 2650 feet a second on emerging from the barrel, travels more than four times as fast. Of course this velocity is not sustained, as there is a continuous loss caused by the resistance of the air through which the bullet passes. However, when the bullet has traveled 1000 yards, it has a remaining velocity of 1185 foot seconds, or nearly twice that of an airplane. In accomplishing the above, the pressure must not exceed 48,000 pounds per square inch.

In the proof of ammunition there are, of course, tests for accuracy and pressure. The accuracy test consists of several series of 10 shots each, fired at a target 500 yards from the muzzle. The accuracy required depends upon the type of objectives and the purposes for which the ammunition will be used. In the pressure test, a pressure barrel is used and maximum pressure limits must not be exceeded. Cartridges also must pass a waterproof test.

Having passed the required acceptance test, the ammunition usually is packed in cardboard cartons, each containing twenty rounds. These cartons are in turn packed in wooden boxes which have terne plate liners. These boxes contain 75 cartons, or 1500 rounds. Cartridges also are packed in bandoleers when for rifle use. Each bandoleer has 6 pockets, each holding 10 rounds (2 clips of 5 rounds each). When so packed, a standard box contains 1200 rounds of ammunition.

Each packed liner is soldered and tested for leaks under four pounds' air pressure to protect the ammunition under all climatic conditions encountered by our Army, Navy, or Marine Corps.



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BEGINNING OF A ROCKET FLIGHT, AUGUST 26, 1937

What Can We Expect of Rockets?

Gunless Artillery and Long Ranges Are Possibilities

By James R. Randolph*

ROCKETS appear to have been invented almost as early as guns and to have enjoyed for a time an equally rapid development. Early in the nineteenth century the Congreve rocket was used effectively in war, attaining ranges up to 3500 yards, which was better than the cannon of the day. Rockets were part of the equipment of European armies until past the middle of the century. But then the development of rifling and breech loading gave the gun a decisive advantage, and rockets, except for signaling, largely fell into disuse.

There are two reasons for this. One is that the rocket, like the steam turbine, depends much more on thermodynamics for efficiency in design than does the gun. The other is that the rockets so far constructed have been inherently less adaptable because of the blast of flame that strikes back on the mounting. However, during the World War, Dr. Robert H. Goddard, head of the physics department at Clark University, directing rocket research under the War Department, developed rockets which did not produce a flame after leaving the firing tube. The firing pressures of these rockets were sufficiently reproducible as to avoid the necessity for a large factor of safety. Rockets were demonstrated which were fired from thin steel tubes, held in the hands.

There are certain advantages the rocket has over the gun, and certain conditions in which it seems likely that it will replace the gun, even as the turbine has replaced the reciprocating steam engine for such uses as power generation and marine propulsion, and, at the other end of the scale, for service where low first cost is the prime essential.

In the future use of rockets for military purposes, two widely different possibilities are indicated. One is the development of a gunless artillery, in which the greatest loads to be transported will not be more than two or three times the weight of equivalent cannon ammunition. The other is for bombardment of cities and other large targets at extremely long ranges. It is theoretically possible, in fact, to conduct such bombardments half around the world, though the expense naturally would be very great.

This wide gap, and the apparent lack of possibilities between, is due to the fact that as ranges increase, the importance of fuel efficiency becomes very much greater. And once we go beyond such solid propellants as smokeless powder we find it necessary to use liquid oxygen. Oxygen boils at -297° F. at atmospheric pressure. And though the boiling point is increased by pressure, the highest values it can attain always will be far below zero, necessitating elaborate apparatus at the firing point.

But it is possible that, once developed, there may be applications of liquid-fuel rockets that will more than offset the disadvantage of handling liquid oxygen; for example, the firing of explosives over great ranges without the use of heavy artillery, and the automatic guiding of such rockets toward airplanes, with the propelling charge remaining in the rocket exploding on reaching the plane. According to recent press notices, liquid air already has been in use in very effective bombs dropped from airplanes in a raid at Barcelona.

On the other hand, the rocket does not have the gun's inherent limitations of size and range. If we have built a successful rocket with a useful load of one ton, a hundred rockets fastened together should carry a useful load of one hundred tons. If a rocket can give itself a velocity of 1000 feet per second, a larger rocket can be used to give it that before it starts to burn, and the resultant velocity will be 2000 feet per second. This is known as a multiple-stage rocket, and theoretically there is no limit to it.

IN ORDER better to understand the possibilities of rocket development, and its limitations, it is well at this point to make a brief theoretical analysis of the rocket. The action is like the kick of a gun. Using the notation of calculus, let us say that in a very small interval of time there issues from the nozzle of the rocket a very small weight of gas, dm, having the jet velocity c. Then, according to the simple momentum equation, the recoil of this jet will give to the rocket a small increase in its velocity, dv, such that

$$cdm = Mdv$$

where M is the mass of the rocket at the time.

Integrating this equation between the limits $M = 1$ and $M = p + 1$ we get $\log_e (p + 1) = \frac{v}{c}$ or $p = e^{\frac{v}{c}} - 1$

where p is the weight of propellant required to give one pound of rocket an increase in velocity v, and $e = 2.71828$.

In tests carried out before the World War, Dr. Goddard obtained values of c as high as 8000 feet per second, using smokeless powder, while with more efficient fuels values of $c = 12{,}000$ feet per second have been obtained. If we substitute these values, and various values of v, in the above equation, we get the following table:

Values of p *for various values of* c *and* v

v	$c = 6{,}000$	$c = 8{,}000$	$c = 10{,}000$	$c = 12{,}000$
500	0.087	0.0645	0.0512	0.0426
1,000	0.182	0.133	0.1051	0.087
2,000	0.395	0.284	0.2215	0.182
3,000	0.648	0.455	0.35	0.284
4,000	0.947	0.648	0.492	0.395
5,000	1.3	0.869	0.648	0.516
10,000	4.3	2.49	1.788	1.3
20,000	27.	11.2	6.4	4.3
36,000	400.	89.	35.6	19.01
48,000	3,000.	400.	121.	51.4

The velocity of escape for the earth is 36,700 feet per second, while a velocity of 48,000 feet per second would be sufficient to go to Mars. This part of the table is merely a reconnaissance, for in an actual rocket the weight of the fuel would probably have to be less than that of the metal parts of the rocket (p less than 1). But it serves to show the effect of increasing efficiency at higher velocities.

*Major, Ordnance Reserve, U. S. Army. Kingston, R. I.

This higher efficiency, however, necessarily is obtained at a price. For we may write, for the kinetic energy corresponding to velocity c, the equations

$$W = \frac{c^2}{2g} \quad \text{and} \quad W = \frac{R}{k-1}(T_1 - T_2)$$

in which R is the gas constant—53.34 for air—and k is the ratio of specific heats—1.4 for air. Using these values, we get the table below in which the temperatures T_1 and T_2 are degrees Fahrenheit, absolute, between which a gas will do work (W) per pound in adiabatic expansion, and will give itself the velocity c.

Kinetic energy and temperature range for various values of c

c	W (ft. lbs.)	W (B.T.U.)	$T_1 - T_2$
6,000	559,000	720	4,200
8,000	994,000	1,276	7,440
10,000	1,552,000	1,994	11,630
12,000	2,238,000	2,872	16,750

It would appear from this table that the temperatures produced in the combustion chamber are far higher than any known material can stand and that this means further complications and weight for cooling or else the confining of the rocket action to so short a time that the heat is not able to melt the chamber and the nozzle before their work is done. These problems are not insoluble. Working under grants from the Daniel and Florence Guggenheim Foundation, in Roswell, N. Mex., Dr. Goddard has obtained flights with chambers using continuous burning of liquid oxygen and gasoline. Although tests have not yet been made to develop these chambers to the highest possible point of efficiency, they nevertheless do not burn out, do not become eroded, and can be used repeatedly.

For the present, however, the rocket seems less promising as a motor than as a substitute for the gun; instead of a projectile being given a certain velocity by gas pressure in the bore of a gun, it is given that velocity by the reaction of a gas jet issuing from the projectile itself.

DR. GODDARD'S early work was done with smokeless-powder rockets, and his paper on the subject, "A Method of Reaching Extreme High Altitudes", was published by the Smithsonian Institution in 1919. During the World War he was director of research under the War Department, on both multiple-charge rockets and on rockets using a single charge of smokeless powder. Demonstrations were made of both these types of rocket.

Structurally, these single-charge Goddard rockets were very simple. There was a steel chamber to hold the propelling charge and a long tapered nozzle in the rear through which the gas jet issued. This nozzle was like those of steam turbines, in that the mouth was much larger than the throat to allow for expansion of the gas.

As far as can be seen at present, the manufacturing problems would be very simple and the device unusually well adapted to procurement planning. But there are problems of design that stand in the way of effective use, and these are just the sort of problems that should be worked out in time of peace. They cannot be speeded up by putting more men to work on them. They are not the sort of problems in which money can take the place of time.

One of these is the problem of getting the rocket started in the right direction. Once the rocket action has ceased, the artillery rocket behaves like any other projectile. But while the action is going on it may create a serious error of aim. Several solutions have been proposed. One is to spin the rocket as a rifle projectile is spun, either by small tangential rockets that function before the main rocket starts, or by rifling in a starting tube. Such a tube would not have to stand pressure, and so would be much lighter than a cannon. Another plan is to use a starting tube long enough to cover the entire space of the rocket action. Another is to use a shorter tube, and have the rocket rotate slowly, like an arrow, to remove the effects of unbalance. In Dr. Goddard's experiments, rockets were given an initial spin by a simple means in the firing tube. Further, there was no backward blast on leaving the firing tube, even when the latter was comparatively short.

These suggestions, and probably others, will have to be tried out and the most effective rocket reduced to a practical and economical design. It is reported that at the present time a great deal of work is being done abroad on this problem, especially in Germany and in Soviet Russia.

ANOTHER problem is the production of an explosive that will have a stable burning rate at pressures in the neighborhood of 1000 pounds per square inch; most cannon pressures are around 38,000 pounds. This would require the combustion chamber to be excessively heavy, without a compensating gain in efficiency. Preliminary computation of design details suggests that a pressure in the neighborhood of 1000 pounds would be the most economical.

With these problems satisfactorily solved, the artillery rocket would present some very interesting tactical possibilities. These arise chiefly from the great reduction in the maximum load to be transported, as compared with cannon. Hence rockets can be taken further toward the front than is desirable with guns, and thus may have a shorter range. Moreover, they can be carried by men, by horses, by dog sled, or by canoe through regions where wheeled vehicles cannot go. Rockets would be of little use against tanks or other moving targets. But they would be at their best in country that is too rough for tanks, and in which all forces have to move slowly.

The fact that the rocket's firing device would probably cost less than one per cent of the cost of an equivalent cannon would enable a much larger number to be fired at once, and certain other characteristics of the rocket would require it. When a fortified position is to be reduced by cannon, the bombardment often lasts for several days, giving the enemy ample time to bring up reënforcements. With rockets, the whole artillery preparation would probably be shot off at once, or in several volleys. The enemy would think himself safe in a quiet sector; his men would be out of their shelters and off their guard; then suddenly a whole bombardment of rockets would come plunging down on them, followed immediately by the attack. This was the intent of the Livens projector. But the rocket has much greater possibilities of size and range.

Cannon will continue to be used against visible targets, and for situations where it is desirable to keep on firing over an extended period of time. Rockets, when successful, may replace them for indirect fire against fixed targets, especially where a large number of simultaneous shots would be desirable. And they can be used for interdiction fire when such fire does not have to be maintained continuously. In many

cases, however, the choice of cannon or rocket is likely to be made on the basis of availability. The cannon may be better where wheeled vehicles can readily go; the rocket where they cannot.

Because of the absence of flame after leaving the firing tube, rockets of the Goddard type were considered for use on planes during the last war. However, in general, air warfare is a matter of quick action and rapid fire against visible targets, which is just the type of service for which the rocket is least suited. On the sea, however, and possibly on the land, rockets offer the possibility of having a very large projectile carried by a small boat or vehicle. Armor-piercing rockets, equal in power and range to a 16-inch gun, probably could be mounted on submarines, destroyers, and other small craft, thereby making them a much greater menace to the battleship than they now are.

Rockets would be very helpful in coast defense, greatly increasing the area of protection, providing a weapon comparable in effect to the heaviest cannon, yet a great deal easier to move from place to place. Where a 14-inch railway gun on the move is identified readily by hostile aircraft, an equivalent rocket on the move probably would be riding in an ordinary motor truck, indistinguishable from ordinary civilian traffic.

AMONG nonmilitary rocket experimenters today, the smokeless-powder rocket is generally considered a back number. For the most part, these men are interested in exploration of the atmosphere beyond the reach of stratosphere balloons, and in the prospect of interplanetary travel. For greater efficiency and greater safety they have turned to liquid fuels. All these involve the use of liquid oxygen. Most of the experimental work being done at the present time is with gasoline, but liquid hydrogen also is being used to some extent. The difficulties in the use of liquid oxygen and liquid hydrogen are chiefly due to their low boiling points. That of oxygen is -297° F., and its freezing point -362° F. Hydrogen boils at -423° F. and freezes at -434° F. Absolute zero is -459° F., so that the use of liquid hydrogen requires temperatures almost as cold as anything can possibly be.

Modern liquid-fuel rockets consist essentially of a combustion chamber having one or more expanding nozzles, valves for regulating the flow of gasoline and oxygen, a tank for liquid oxygen, and a tank for gasoline. To the latter is attached another tank containing nitrogen or carbon dioxide under pressure. This inert gas serves to force the gasoline into the combustion chamber. Oxygen's tendency to boil usually is depended on to force it to the combustion chamber.

The need for elaborate apparatus at the starting point is bound to limit the military use of such rockets, although attention is called again to the press reports that "liquid-air" bombs were used at Barcelona. But, give them a ship of sufficient size, or a land base to which the necessary equipment can be brought, and liquid-fuel rockets present some interesting possibilities because of their great potential size and range.

In the present state of the art, there probably would be no great difficulty in equaling with rockets the performance of the German long-range gun that bombarded Paris from a distance of seventy-five miles. But instead of firing shots of moderate caliber at long intervals, a rocket plant could fire the equivalents of 24-inch shells about as fast as desired. Such a job would be no more ahead of present practice than war-time bombing raids were ahead of the airplanes of 1913. And this is only the beginning.

ACCURACY is another problem. The German long-range gun used the whole city of Paris as a target, and seems to have been incapable of hitting any particular part of it at will. Yet the projectiles from this gun went well up into the stratosphere, and this decreased the difficulties due to atmospheric conditions. Ocean-crossing rockets would be out in the vacuum of space for most of their journey; even then a target the size of New York City is a very small one to hit at 3000 miles!

Hence it seems likely that these rockets will be made of sufficient size to justify the carrying of a pilot. With increase in size, the efficiency of the rockets also can be increased, as it will be possible to dispense with the pressure tanks of present rockets and to use pumps for the fuel and for the liquid oxygen. The pilot can regulate the flow, and produce greater burning efficiency than is possible in an unregulated rocket.

Against large targets, however, it might prove possible to combine a rocket and a bombing plane in such a way that the rocket carried the plane to the target and then was abandoned. But all such developments are very much in the realms of speculation. All we can say today is that the possibilities exist.

By contrast with the simple artillery rocket using powder, any sort of man-carrying rocket will have to accelerate very moderately. Artillery rockets may get up to full speed in a hundred feet or less. It must be remembered that there is a limit to the acceleration the human body can stand and remain alive. What this limit is, man does not know accurately. Human beings have been tested up to 160 feet per second per second, and have suffered no ill effects. Many times, in accidents, the human body has been subjected to a much faster deceleration than this without damage, but no accurate data are available.

Moreover, the speeds attained by rockets intending to travel more than a thousand miles probably will be such that they cannot be attained or maintained in the atmosphere. An interplanetary rocket, with its speed of more than seven miles per second, would probably not be going faster than a mile a second at the upper limit of the atmosphere. The rest of its speed would be attained when traveling out in space.

Slow acceleration reduces air friction. The rocket is more efficient in a vacuum than in air. But the rocket is under the pull of gravity all the time it is up, and this is equivalent to adding thirty-two feet per second to the velocity it must be designed to produce for every second the rocket acts. A rocket capable of producing an acceleration of only thirty-two feet per second per second would not rise in the air at all—it would drift along until its fuel gave out. Its efficiency would be zero. Efficiency increases as the rate of acceleration increases, but this must be balanced against other factors in the design. Thus it will be seen that the development of long-range liquid-fuel rockets is beset with numerous problems and difficulties.

We do not know yet what the wars of the future will be like, but it seems probable that, in one way or another, rockets will play a part in them.

ARMY ORDNANCE

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Month by Month

FEW MEN HOLDING HIGH PLACE IN AMERICAN industrial life have a longer and more intimate contact with the production of military armament than the new assistant chief of the New York Ordnance District, Col. Thomas F. Brown, Ord. Res., whose appointment to that important office was announced recently by Maj. Gen. C. M. Wesson, Chief of Ordnance. Colonel Brown succeeds the late Col. F. W. Roller, Ord. Res. Ordnance friends, including the loyal group who guided the Department's destinies before the World War and that much larger contingent whose acquaintance began in 1917-1918, will join with ARMY ORDNANCE in congratulating the New York District on its good fortune and in felicitating Colonel Brown on his honor.

Colonel Brown began his military service during the Spanish-American War when he enlisted with the 43rd Infantry and served two years in the Philippines. For twelve years, from 1903 to 1915, Colonel Brown served at the Watertown Arsenal, Watertown, Mass. During that tour of duty he was sent to the Hadfield steel plant at Sheffield, England, by the then Maj. Charles B. Wheeler, commanding officer of the arsenal on the recommendation, approved by Brig. Gen. William Crozier, Chief of Ordnance, of the then Capt. C. M. Wesson and the then Maj. C. C. Williams. There he made a study of the methods of manufacture of armor-piercing and deck-piercing projectiles and other ordnance matériel. Colonel Brown returned to the United States in 1912.

The sponsors of this study were destined for important ordnance responsibilities. Major Williams became the renowned Major General, Chief of Ordnance whose leadership and ability have influenced ordnance progress for the past twenty years and whose character is held in increasing admiration by all who know the ordnance record. Captain Wesson was destined to hold his present high position as Major General, Chief of Ordnance, an office wherein but six short months, July to December 1938, have proved his administrative acumen and productivity of results in the current ordnance program. Major Wheeler was to become the Acting Chief of Ordnance during the trying days of our World War experience after a career of distinction in the Ordnance Department during the first quarter of this century. General Crozier was then in the midst of his renowned career as Chief of Ordnance.

Upon Colonel Brown's return from England in 1912, a projectile plant at the Watertown Arsenal was begun. History has shown that it was a successful installation. During this period also he served short details in the office of the Army Inspector of Ordnance at the Bethlehem and Midvale Steel Companies and temporary tours at the Frankford and Watervliet Arsenals. As a captain of the 8th Massachusetts Infantry, he served on the Mexican Border in 1916 as assistant to the then Lieut. Col. C. C. Williams, Ordnance Officer on General Pershing's staff at Columbus, N. Mex.

Commissioned a major in the Ordnance Department Reserve in 1917, he was designated as commanding officer of the Enlisted Men's Training School at Watervliet and later of the Ordnance training courses at Camp Johnston, Columbia, S. C., and at Camp Hancock, Augusta, Ga. As a member of the American Supply Board he visited numerous plants in the United States, France and Great Britain, studying the methods of ammunition supply from factory to front. He was promoted to the rank of lieutenant colonel, National Army, in January 1918. Later he was assigned as officer in charge of Ordnance training schools in France. Upon his return to the United States in 1919, he served as contracting officer in liquidating war claims in what is now the First Corps Area. He has held a commission in the Ordnance Reserve Corps since his discharge from active service, and recently was promoted to the grade of colonel.

His industrial service has been one of unusual responsibility. After leaving the Ordnance Department in 1915, he became works manager of the Framingham Foundry and Machine Company where agricultural, printing machinery and other large equipment were manufactured, and where, in addition, 75-mm. shell were produced for the Russian Government. Following his honorable discharge from the Army in 1919, Colonel Brown became president of the Industrial Engineering Corporation specializing in the design, equipment and installation of numerous manufacturing establishments.

As vice-president of the National Distillers Products Corporation, which position he now holds, Colonel Brown is in charge of operations of that corporation and its subsidiaries. Identified with many professional, scientific, and patriotic societies, Colonel Brown is a charter member of the Army Ordnance Association and has written extensively on subjects connected with his long and varied service. In the field of ordnance these include a handbook for officers of the Reserve Corps and a text on the administration of field ordnance depots published during the World War.

Here then is a new official in the ranks of industrial preparedness who by experience, ability, and personality has proved his worthiness for the ordnance cause in the United States. ARMY ORDNANCE salutes the new assistant chief of the New York Ordnance District, confident of his determination to do as loyally and as zealously for industrial preparedness in the years that are to come as he has done in the years that have passed.

THE FIRST STEP IN THE PLACEMENT OF EDUcational orders for noncommercial military equipment has been taken. A number of manufacturers have been selected for each item on the list of approved matériel, and invitations to bid have been offered to them. The items on the list approved by the President for which educational orders can be awarded this year are, as announced in the last issue of ARMY ORDNANCE: semiautomatic rifles, recoil mechanisms for 3-inch antiaircraft guns, forgings for 75-mm. shell, machining processes for 75-mm. shell, gas masks and 60-inch searchlights. It is anticipated that all educational orders under the program for the current year will have been placed before the end of January 1939.

The educational-orders legislation permits the War Department to select manufacturers without competition, but it has been decided to ask for bids on the first year's program. Funds in the amount of $2,000,000 have been approved for this purpose. Under the direction of the Assistant Secretary of War, Mr. Louis Johnson, a plan has been worked out whereby the benefits of the competitive system of awarding contracts may be combined with those of the system of selecting the firms known to be the best qualified. Under this plan a number of manufacturers have been chosen because their plants and experience, the Department believes, warrant the placement of educational orders with them. In other words, the present administration of the act is based upon the selection of qualified manufacturers from whom proposals will be received, and then educational orders will be awarded among these on the basis of competitive price.

This seems to be a sound procedure both for the protection of the interests of the Government as well as those of the producer. In this way the War Department is assured that its educational-order dollars, which are extremely limited and might well be increased fifty times, go furthest. Likewise discrimination between several fully qualified manufacturers is obviated.

Theoretically, educational orders and unit cost are contradictory ideas. For example, it might be worth $10,000,000 to the national defense of the United States to educate one of our large quantity producers of peace-time products to the manufacture of military matériel. And as experimental costs go among large commercial producers the sum is small. But the Congress has provided $2,000,000 this year, and there are many more items of military equipment for which costly educational orders should be let. The Assistant Secretary of War has said: "The $2,000,000 will teach industry to produce but six indispensable items or processes. Not until we have educated the 245 additional plants in the manufacture of the other 49 critical items can we feel that we are on the road toward the achievement of our objective. Among those 49 items are such vital necessities as bomb sights for airplanes, canisters for gas masks, demolition bombs and fuzes for ordnance, aiming circles and range finders for the artillery, and the new 37-mm. guns and carriages for the infantry and the antiaircraft service."

To find a balance between the ideal and practical is as commendable as it is urgent. The first year's operation of educational orders on the limited-competition basis itself will have an educational feature by which both Government and industry stand to learn some equally valuable lessons. Thereafter, procedure to guide and protect teacher and student will be more certain because based on experience.

THE PROTECTIVE MOBILIZATION PLAN OF 1937, which is now the governing policy of the War Department, is explained fully for the first time in the very enlightening annual report for 1938 of Mr. Woodring, the Secretary of War. This plan contemplates, in the event of a major war, immediate employment of an initial protective force of approximately 400,000 men. This force will comprise existing units of the Regular Army and National Guard at existing strength, augmented by such recruitment of personnel with prior military training as the exigencies of the military situation will permit. Under the protection of this initial defensive force, there will be progressively mobilized, trained, and equipped such larger national armies as the national defense of the United States demands. The "protective" intent of this military policy is clearly evident from every viewpoint.

To quote Mr. Woodring: "At the very outbreak of war the 400,000 officers and soldiers of the initial protective force must be so trained and so equipped that there can be no question whatsoever as to their ability to withstand any onslaught until such time as their thin ranks can be augmented by units of the Organized Reserves component of the Army of the United States. We place a tremendous responsibility on these first 400,000 defenders. If they fail in their protective mission the fate of the reënforcing citizens' armies is sealed." Thus the question of the adequacy of equipment for this force becomes one of paramount importance.

The prospect is not nearly as assuring from the equipment standpoint as it is from the man-power standpoint. Shortages, deficiencies and bottle necks in this field were fully explained by the Assistant Secretary of War, Mr. Johnson, in an address at Chicago on December 3, 1938, when he outlined the needs of a forthcoming armament program. He noted well that our future program will not be labeled "rearmament" for, militarily speaking, America never has been armed.

But of shortages in essential equipment there are many. Mr. Johnson called attention to some of the most glaring. Practically all the gun carriages of our French 75's belong to an old model designed more than forty years ago. The range with this carriage is 9000 yards. Of our improved mobile type with a range of 13,500 yards, the United States Army has only 112. Of the modern 105-mm. howitzer capable of double the fire power of the 75, we have none. Of modern 155-mm. howitzers for counterbattery work, we have none. The Ordnance Department has developed two improved modern heavy calibers in the 155-mm. gun and the 8-inch howitzer, but today there are but four of these pieces in the entire Army.

The needs of the protective mobilization plan must be met at all costs. More elaborate defense plans may be advisable or inadvisable but about the protective plan there can be no question. The Army, and particularly the Ordnance Department, are making great strides at the present moment toward building up urgent deficiencies of military equipment, but the deficiencies have been great for many years and we do not believe the people of the United States will be content until all deficiencies which may hinder the successful application of the protective mobilization plan have been met. The job is essentially a production program. The Ordnance program of the current year is well under way and its tempo should be sustained until deficiencies in equipment under the protective mobilization plan are met.

The Industrial Mobilization Plan

An Editorial

THE esteemed *Saturday Evening Post* worked itself into a thick editorial lather in its issue of November 26, 1938, when it devoted a page and a half to an essay against the Army and Navy's Industrial Mobilization Plan. A comprehensive title of the plan, the *Post's* editorial suggests, would be "Articles of War-time Dictatorship." The essay is called "The Betrayer of Popular Government"! Both labels in themselves are ground for our regret at seeing the *Post's* editorial page thus reduced to the same level of seriousness as its "Little Lulu" cartoons.

In commenting on this gem of extravagant writing, we first insist upon dispelling all connection or concern on our part with politics. We are not so sure that the *Post* is as neutral. Politics has no place in preparedness. The evolution of the Industrial Mobilization Plan has been nonpolitical and nonpartisan. The plan is the result of study, research, counsel, and advice of many minds, civilian and military, professional and lay, over many years. In so far as civilian participation in the evolution of the plan is concerned, members of both major parties can share the praise jointly because the men who have aided in the plan's development have done so with complete disregard of party affiliation. The plan, and the National Defense Act of 1920 upon which the plan is based, are the result of World War experience on the one hand and, on the other, direction from many of the most patriotic, talented, and sincere men in public and private life during the past twenty years. That this be emphasized and understood at the start is extraordinarily important.

The Industrial Mobilization Plan of today, in its essentials, was begun during the presidency of Calvin Coolidge. Indeed its genesis goes back to the war secretaryship of John W. Weeks in the régime of President Harding. It evolved slowly, step by step, under succeeding administrations. It was presented to the War Policies Commission publicly in 1931 and caused no stir. If it was a betrayer of popular government seven years ago, the *Post* would have done well to say so then!

The plan reached its first complete public form at the close of the administration of President Hoover when, bearing the date 1933, it became a public document that all might obtain copies from the Public Printer at the prohibitive cost of fifteen cents each and read it. If the *Post's* dictatorship worries are to be gauged by its own alertness, then the passage of five years of silence on that great journal's part bespeaks a woefully weak interest in our national security.

A GREAT deal of the *Post's* attack upon the Industrial Mobilization Plan is not an attack upon the plan itself at all but rather upon a draft of a bill sponsored by the advocates of "taking the profit out of war." This bill, sometimes known as the Nye Bill, was added to the legislative annex of the plan only after it had been acted upon by three committees of the Senate; *viz.*, the Munitions, Military Affairs, and Finance committees. There is ground for serious objection to the bill but not because of its provisions for taking the profit out of war. May we observe that as practical war-time matters, profit controls are proper and certain. Excessive profits must be taken out of any future war—preferably through price limitation and taxation enacted at the time. The basic objection to the Nye Bill lies in its well-intentioned but dangerous effort to define the war powers of the President. These powers never have been and never can be defined. Attempt at definition should never be made for the simple reason that to define these powers is to limit them. That great pioneer of industrial preparedness, Frank A. Scott, first chairman of the General Munitions Board, 1917, has emphasized this point repeatedly. The head of the United States Government in any future war, whoever he may be and whatever his abilities or shortcomings, must not be circumscribed by meticulous definition as to his actions when the country itself is in a death struggle with an enemy—whether the emergency be foreign or domestic.

This may seem to the *Post* and to political alarmists to be the view of one who leans toward war-time dictatorship. It may be said that these views in the pages of a military journal have hidden motives smacking of the Fascist or Nazi or Communist. At least, some will say, they are undemocratic. They are nothing of the sort. They are good sound traditional Americanism. The convictions on which these views are based are part and parcel of the military history of our country. They are basic as tenets of discipline. The war-time powers of every President have been, are, and must ever be, close to the absolute for the very sound practical reason that *in time of peril there can be but one leader.*

What more absolute dictator could there be than one who would set aside the writ of habeas corpus—the most fundamental guarantee of basic human rights? Using the *undefined* war powers of the President, none other than President Lincoln did just that. What democratic principle did the same Chief Executive follow when, by one stroke of his pen, without the advice and consent of the Congress but using his undefined war powers, he issued the Emancipation Proclamation? Or again, who surpassed that lover of democratic principle, Woodrow Wilson, in his exercise of the war powers—eminent domain, price control, priority, etc., etc.—powers all without which the war might have been lost?

These are elementary ideas to the student of military affairs. Also elementary is the axiom that in time of peace detailed legislation to govern unknown war-time situations should not be adopted. Consequently, sincerity demands that any bill, by whatever name, which attempts to define, and therefore to limit, the all-inclusive war powers of the President of the United States, easily may be the very cause of defeat in some unknown, undefinable situation of future days. Victory alone, won by the rules of civilized warfare, is the objective of a just war, and if there are unnecessary legislative limitations on victory, such limitations are tantamount to defeat.

BUT the Industrial Mobilization Plan is not the Nye Bill. What then is it? The Industrial Mobilization Plan is a tentative outline resulting from combined studies under the Army and Navy to guide and assure the utilization of American industrial power in time of war. Authority for

such study and for the plan lies in the organic law of the land, Section 5a of the National Defense Act, wherein the Assistant Secretary of War is given the responsibility of making adequate provision for the mobilization of matériel and industrial organizations essential to war-time needs. All Assistant Secretaries of War since the adoption of the National Defense Act in 1920 have religiously complied with this duty. The political complexion of the incumbent has had nothing whatsoever to do with the formulation of the plan. It has nothing to do with the plan now.

The plan is not of recent origin, as we have said. After many years of study, analysis, and research, it was first presented, essentially in its present form, to the War Policies Commission in 1931. As a result of the studies of that commission, its principles were embodied in the revision of 1933 as approved by the War and Navy Departments. Following a jitterbug munitions investigation, the Industrial Mobilization Plan of 1933 became the object of both favorable and unfavorable comment. As the result of the latter, certain changes were made in the plan when it was revised in 1936. One of these was to include in the legislative annex to this plan a proposed bill which became practically identical with the industrial features of the proposed "war-profits legislation" and later of the Nye Bill. The war-profits legislation was included at the behest of a Congress which was determined, willy-nilly, to soak the arms makers and to smoke out all "profiteers". So it appears that a gesture by the War and Navy Departments meant in the best of faith; *i.e.*, the inclusion of the Nye Bill in the legislative annex of the plan, is a source of misinterpretation.

If American war-time experience proves one thing more than another, it is that the absence of definite industrial mobilization plans in every war in which the United States has engaged has resulted in a terrific and useless cost in life and property. For all our ingenuity, the trial-and-error method was the tragic American way. But now we have a tentative plan utilizing the lessons of our World War experience. That experience was a nightmare. Despite our industrial genius, it took us fourteen months to get going industrially in the World War. Shall we trust to luck to muddle through every war, squander our substance and invite defeat, or shall we plan to reduce the time and the cost in lives and dollars—and assure victory as well? We cannot always depend upon allies to provide our guns while we go on our leisurely way. Hence the plan.

MR. WOODRING, our Secretary of War, stated this thought succinctly two years ago. When he announced the present version of the plan to the public on December 10, 1936, he said: "This plan utilizes all the best of the World War experience. We know that mistakes were made in the World War. Such mistakes were inevitable under the confused conditions existing at that time. These mistakes have been carefully studied and analyzed and this plan is built to insure orderly and effective industrial support to the military effort and to obviate through careful and intelligent planning the recurrence in another war of mistakes such as occurred in 1917 and 1918.

"This Industrial Mobilization Plan is a public document. We desire the public to know of its existence and what it contains. The important relation of industry to war is being more and more stressed in the world today and the development in this country of sound and workable industrial plans will prove a distinct asset in the event we should unfortunately be forced into another war. Effective industrial planning is an indispensable element in adequate national defense and therefore we know it to be in the interest of security and peace."

But at no time has any properly informed person claimed that the Industrial Mobilization Plan in all its provisions is the way, and the only way, the United States *must* fight a future major war. So to claim is to invite disaster. Every student of the subject has contended from the start that industrial-mobilization planning changes with the tides of human fortune. What may appear an advantageous remedy in 1938 may be obsolete by 1940, just as what appeared to be advantageous in 1931 before the War Policies Commission, was anathema in 1934 to the Senate Munitions Committee. The proper attitude is one of constant alertness. This attitude therefore challenges the political sophistry that industrial war plans can be fixed on a day certain for a war to be fought no one knows when.

THE present plan does not aim at the militarization of industry or of any civilian enterprise. Indeed its purpose is to achieve the results without imposing the limitations of martial processes. The plan aims to save our country and to sustain every one of its institutions. We have the deep conviction that the way—and the only way—to save our institutions in time of war is to uphold discipline at home just as our fighting forces uphold it at the front. Frankly, John Q. Citizen, doughboy at war, can't do as he pleases about everything under the sun. Neither can Senator Marmaduke Whozis or columnist Ethel Alert. If that be a denial of democratic rights for the duration of the war then it is a denial of democratic rights for the winning of the war! And the greater good comes first.

Therefore, what the editors of the *Saturday Evening Post* should do in justice, is: (a) Study the Industrial Mobilization Plan, 1936; (b) See the degree of common sense based on practical experience which permeates the entire document; (c) Realize the necessity in peace time for this sort of a study of war-time procedure; (d) Drop all partisanship when the subject matter relates to the national defense and remember that the plan is the work of twenty years of study by the Army, Navy, labor, industry, and professional leaders; (e) Realize that the Nye Bill is not an essential part of the plan but simply a part of its legislative annex. This was a Congressional demand. Two brief years have shown the need for the elimination of such legislation from the annex.

From this we deduce two conclusions, both of which are clear. If the people of the United States in their zeal for that shadowy thing called "taking the profits out of war" demand legislation *now* for taking the profits out of some future, unknown war, let's have that legislation. But let us all realize that any bill enacted into law in peace to define the Presidential war powers is essentially harmful to our national well-being. The Commander in Chief, whoever he is and whatever his political philosophy, must be free to lead the nation as the dangers of the situation and the depredations of the enemy demand. The second conclusion is that the Industrial Mobilization Plan at heart is a *current* study for utilizing the aggregate power of the United States to support her military effort whatever, whenever, and wherever that may be. But today's plan may not fit tomorrow's war. That is why it should be a *plan* and not a *law* in peace time.

Association Affairs

COMMITTEE OF THREE HUNDRED ON TWENTIETH ANNIVERSARY

THE nation-wide Committee of Three Hundred to observe the twentieth anniversary of the Army Ordnance Association has completed its organization, and the first steps toward its program for the year 1939 have been taken. Col. Frederick H. Payne, of Greenfield, Mass., a vice-president of the Army Ordnance Association and former Assistant Secretary of War, is the general chairman of the committee. The honorary chairmanship is shared by Maj. Gen. C. M. Wesson, Chief of Ordnance, U. S. Army, and Brig. Gen. Benedict Crowell, president of the Association and World War Director of Munitions.

The purposes of the Committee were outlined by the chairman in a general letter sent early in December to all members. "Our first objective," wrote Colonel Payne, "will be to observe twenty years of industrial preparedness; *i.e.*, the twentieth birthday of our society. This we hope to do through meetings under the auspices of our various sections and a nation-wide annual meeting preferably at the Aberdeen Proving Ground in October.

"Our second objective will be to build up our membership to numbers befitting the importance of our aims. To this end I hope that the various sections will lend every possible cooperation through personal contacts of their members toward the attainment of a membership at least double our present size."

The executive committee consists of the section chairmen and the three former Chiefs of Ordnance—Maj. Gen. William Crozier, Maj. Gen. C. C. Williams, and Maj. Gen. Wm. H. Tschappat. The Committee of Three Hundred is divided into fifteen sections, of which the following gentlemen are chairmen: Birmingham: Col. Theodore Swann; Boston: Lieut. Col. C. S. Robinson; Chicago: Edmund A. Russell; Cincinnati: Walter W. Tangeman; Cleveland: Col. Winthrop Withington; Hartford-Bridgeport: Col. B. A. Franklin; Los Angeles: Earl B. Gilmore; Milwaukee: Col. Wm. W. Coleman; New York: Brig. Gen. Samuel McRoberts; Philadelphia: P. H. Gadsden; Pittsburgh: Col. H. A. Gidney; Rochester-Buffalo: Frank J. Smith; St. Louis: Col. Harry Scullin; San Francisco: Roland L. Oliver, and Washington: Lieut. Col. LeRoy Hodges.

PHILADELPHIA PREPAREDNESS MEETING

COÖPERATION between the Ordnance Department of the United States Army and Philadelphia industry was the theme of a program in which the combined engineering and industrial societies of Philadelphia participated on November 9, 1938. The general chairman was Lee P. Hynes representing the American Society of Mechanical Engineers, sponsor of the meeting.

The participating societies were the local chapters of the Army Ordnance Association, Philadelphia Chamber of Commerce, Philadelphia Ordnance District, U. S. A.; the Engineers Club of Philadelphia, American Society for Metals, American Welding Society, American Institute of Electrical Engineers, Society of American Military Engineers, American Society of Civil Engineers, Association of Iron and Steel Engineers and American Society of Heating and Ventilating Engineers.

The keynote of the occasion was sounded by Maj. Gen. C. M. Wesson, Chief of Ordnance, who spoke briefly at the banquet which was held in the ballroom of the Bellevue Stratford Hotel at 7 P. M. William F. James, president of the Philadelphia Chamber of Commerce, presided at the banquet, and 382 guests were in attendance. General Wesson's remarks follow:

"IT IS A great pleasure to be present at this splendid gathering of engineers and industrialists—men who not only are busily engaged in their respective fields of endeavor, but men who by their presence here recognize that the first call of citizenship is that we be prepared to defend ourselves against all comers.

"What all of us want is peace! In these parlous times the thought uppermost in our minds is 'How can we, the people of the United States, maintain a real and lasting peace with the other nations of the world?'

"The peoples of the world have striven for peace by various means: by grouping of nations to effect a balance of power, by treaties of nonaggression and arbitration, by trade agreements, by the association of nations into a league for peace, and by general disarmament. With no desire to disparage any sincere effort to attain the much-desired end, my own belief is that preparedness is our only sure and safe guaranty of peace.

"By 'preparedness' I mean not only the organization and equipment necessary for defense, but also the will to win if and whenever we are forced to fight. In planning for preparedness, we must therefore combat all insidious influences that tend to weaken the intestinal stamina of our people.

"Our immediate concern here tonight is war-making matériel. The Department of which I am the head is responsible for supplying the armies of the United States with practically every offensive and defensive weapon required by them. The work you are doing in collaboration with us to the end that our fighting men shall not lack means for waging war—not only war, but *successful* war—is of inestimable value to our country in its effort to maintain happy relations with the other countries of the world. These fighting tools cannot be improvised. Even if large reserves of munitions were available, which unfortunately they are not, we must depend upon industry to produce the major portion of Ordnance equipment required by our armies in war. The sooner production can start, the quicker the Army can be mobilized and equipped. Time gained is still the best ally of victory!

"Plans for prompt production of ordnance are therefore one of our greatest guaranties of peace. My colleague and assistant, Brig. Gen. C. T. Harris, Jr., is going to discuss this feature with you tonight.

"To the end that ordnance production may be facilitated with a minimum of expense and change-over of plants, I pledge the Department to the very practical policy of keeping its designs adapted to production from commercial materials by commercial concerns and, in so far as possible, by equipment now installed.

"The scientists, engineers, manufacturers, and manufacturing plants of Philadelphia and, in fact, of the whole State of Pennsylvania, are indispensable to the Ordnance Department in the production of Ordnance matériel. We are relying on them for a large percentage of our requirements. To show you how well Pennsylvania is adapted to ordnance production, of the $19,000,000 worth of contracts for Ordnance matériel placed with commercial concerns during the past three months, approximately $4,000,000, that is, 20 per cent, has been placed in Pennsylvania.

"In closing, I wish to express my appreciation and thanks to all you gentlemen for your great interest in the Ordnance problem. Philadelphia is the headquarters of one of our most important Ordnance Districts. Here also is located an active post of the Army Ordnance Association. I am greatly pleased at the opportunity of saying these things to you and to make public acknowledgment of the indebtedness of the Ordnance Department and the nation to those fine Americans, Mr. Philip H. Gadsden, chief of the Philadelphia Ordnance District and president of the local post of the Army Ordnance Association, and Mr. William D. Disston, assistant chief of the District. We also are indebted to that splendid group of men who are acting in an advisory capacity to these officials, as well as to the fine

corps of Reserve officers who are training themselves to serve in an emergency, should one unfortunately come."

THE principal address was delivered by Brig. Gen. C. T. Harris, Jr., Assistant to the Chief of Ordnance and chief of the Industrial Service. General Harris presented a detailed analysis of "Plans for Industrial Mobilization," a subject upon which he is eminently qualified to speak, having been identified with the major activities of procurement planning for many years. Other speakers were Charles E. Bonine, president of the Engineers Club of Philadelphia, and Rear Adm. W. T. Cluverius, commandant of the 4th Naval District.

Seated at the speakers' table, in addition to the toastmaster and the guests of honor, were: Col. E. D. Bricker, Ord. Dept., commanding officer, Frankford Arsenal; C. C. Jones, chairman, American Society of Mechanical Engineers; Adolph O. Schaefer, chairman, American Society for Metals; William D. Disston, assistant district chief, Philadelphia Ordnance District; Col. William A. McCain, Q.M.C., commanding officer, Philadelphia Quartermaster Depot; Capt. William McEntee, in charge of inspection, Philadelphia area, U. S. Navy; Maj. Walter C. Hamilton, Ord. Dept., executive officer, Philadelphia Ordnance District; Howard S. Phelps, president, American Institute of Electrical Engineers; Edward G. Hosted, chairman, American Welding Society; Col. Clarence Jordan, director, Philadelphia Post, Army Ordnance Association; Col. Glen F. Jenks, Ord. Dept., consultant on technical matters, Office of the Chief of Ordnance; Col. H. K. Rutherford, director of Planning Branch, Office of the Assistant Secretary of War; Dr. Henry B. Allen, member of Advisory Board, Philadelphia Ordnance District; William E. A. Doherty, president, American Society of Civil Engineers; J. S. W. Holton, president, Society of American Military Engineers; Comdr. William W. Behrens, aide to admiral, U. S. Navy; Comdr. H. F. Newton, chief of Intelligence Division, U. S. Navy; L. V. Black, president, Association of Iron and Steel Engineers; Lieut. Col. L. H. Campbell, Jr., Ord. Dept.; Lieut. Col. L. A. Codd, Ord. Res., executive secretary, Army Ordnance Association; Harry H. Erickson, president, American Society of Heating and Ventilating Engineers, and Maj. C. W. Burlin, C.E.

At the afternoon session, also held at the Bellevue Stratford, two papers were presented by well-known officers of the Ordnance Department who are experts in their respective fields. Several hundred engineers and manufacturers were in attendance at this session. Colonel Jenks, who during his military career has been closely associated with Ordnance scientific work, presented an illustrated lecture on "Development of Welded Gun Carriages," in which he described the technique employed by the Ordnance Department in the construction of various types of matériel. Lieut. Col. L. H. Campbell, Jr., who is in charge of artillery ammunition production at the Frankford Arsenal and whose achievements in the field of ordnance manufacture are well known, spoke on "Manufacturing Problems of Artillery Ammunition." These addresses, with those of Generals Wesson and Harris, constituted a broad presentation of ordnance activities and viewpoints and met with general acclaim by the hundreds who were in attendance.

GOVERNOR HEIL OF WISCONSIN

ANOTHER member of the Army Ordnance Association has entered the exclusive ranks of state governors in the person of Julius P. Heil, the new Governor of Wisconsin. Governor Lehman of New York, who served in the Ordnance Department during the World War, is a charter member of the A.O.A. Mr. Heil is president and treasurer of the Heil Company, manufacturers of steel motor-truck bodies, tanks, oil burners, furnaces, water supply systems. He has been a member of the Association and of the Milwaukee Post since 1921.

Born in Germany, Mr. Heil came to the United States when a small boy and at the age of 12 was an apprentice drill-press machinist in Milwaukee. At the age of 24 he established the Heil Rail Joint Welding Company which pioneered processes for welding rail joints for electric street car lines.

GENERAL TSCHAPPAT HONORED

HONORARY life membership in the American Society of Mechanical Engineers was conferred upon Maj. Gen. William H. Tschappat, U. S. Army, Ret., at ceremonies in New York, December 6, 1938. General Tschappat was cited for his distinguished engineering service during an active military career of more than forty-three years. He was presented for the award by Alex Dow, Chief of the Detroit Ordnance District, and a past president of the A.S.M.E.

NEW MEMBERS

DURING the period October 1 to November 30, 1938, inclusive, the following applicants were admitted to membership in the Army Ordnance Association: Bernard Altshuler, Bethlehem, Pa.; L. J. Armstrong, Detroit, Mich.; George J. Arnold, Cleveland, Ohio; Robert W. Barwood, Philadelphia, Pa.; Herbert W. Bentley, Portsmouth, Va.; W. J. Binkley, Warrenton, Mo.; G. A. Blair, St. Louis, Mo.; G. E. Beggs, Princeton, N. J.; Don S. Bowers, Tulsa, Okla.; Oscar A. Broten, Glen Ridge, N. J.; Douglas R. Brown, Coffeyville, Kans.; William H. Brown, Teaneck, N. J.; C. F. Buck, Jr., Watertown, Mass.

J. E. Candlin, Chicago, Ill.; R. A. Cary, Bethlehem, Pa.; Arnold Christianson, Hammond, Ind.; Erling Christianson, Hammond, Ind.; Noble B. Clark, Cleveland Heights, Ohio; R. A. Colgin, Tulsa, Okla.; Gilbert L. Cox, New York, N. Y.; Willard R. Cox, St. Louis, Mo.; Charles W. Dake, Grand Haven, Mich.; Angelo Del Campo, Fort Sam Houston, Tex.; Charles Drexler, Indianapolis, Ind.; Eugene G. Droesch, Brooklyn, N. Y.; Joseph O. Eaton, Cleveland, Ohio; C. W. Elliott, Union, N. J.; Frank B. Fairbanks, Pittsburgh, Pa.; Claude E. Fertig, Santa Cruz, Zambales, P. I.; Arthur J. Freund, St. Louis, Mo.

J. T. Gearhart, Princeton, N. J.; E. P. Glueck, Bethlehem, Pa.; Louis A. Goalby, Denver, Colo.; J. Clark Godfrey, New York, N. Y.; Ernest Earl Graham, Trujillo, Peru; Wilbur D. Grigg, Newport, Pa.; F. E. Gunter, St. Louis, Mo.; Finis H. Haskins, Cincinnati, Ohio; Francis A. Heine, Reading, Pa.; H. P. Henderson, Laredo, Tex.; Joseph J. Henderson, Caldwell, N. J.; Stanford Leland Hermann, New York, N. Y.; Andrew J. Higgins, New Orleans, La.; William D. Higgins, Honduras, Central America; Raymond L. Hill, Golden, Colo.; Jesse Hiltebeitel, New York, N. Y.; J. Randolph Hoagland, Chicago, Ill.; Walter L. Hodeaux, West Palm Beach, Fla.; Edwin T. Hodge, Portland, Ore.; H. F. Holden, Philadelphia, Pa.; Alfred G. Hollmann, St. Louis, Mo.; E. R. Hough, Princeton, N. J.; Ross H. Huber, Albany, N. Y.

J. T. Irwin, Cleveland, Ohio; Victor A. Ivanoff, New York, N. Y.; Henry M. Jensen, Jersey City, N. J.; H. Johnston, III, Princeton, N. J.; John E. Kalinka, Chicago, Ill.; Chever McM. Kellogg, Webster Groves, Mo.; David C. Kelly, Fort George G. Meade, Md.; Karl V. Klocker, Dubuque, Iowa; William G. Knight, Derby, Maine; Morris F. LaCroix, Boston, Mass.; Gregory S. Lavin, New York, N. Y.; Paul Lehmann, St. Louis, Mo.; W. G. Leonard, Bethlehem, Pa.; Charles V. Lewis, Brooklyn, N. Y.; G. E. Lien, Bethlehem, Pa.; T. R. Lind, Denver, Colo.; R. V. Mackey, Bethlehem, Pa.; Louis W. Martin, St. Louis, Mo.; J. W. Mayers, Princeton, N. J.; Robert W. McLean, Bridgewater, Mass.; Alfred Meier, Wood Ridge, N. J.; C. W. Miller, Cleveland, Ohio; John B. Morris, Cincinnati, Ohio; George M. Morrow, Jr., Birmingham, Ala.; D. C. Myers, Coffeyville, Kans.

Charles J. Nieman, Pittsburgh, Pa.; George T. Nolde, St. Louis, Mo.; P. Arlington Nuetzel, East St. Louis, Ill.; Newell H. Orr, Denver, Colo.; Harry A. Overholtzer, Conshohocken, Pa.; R. M. Pease, University City, Mo.; Carroll E. B. Peeke, Washington, D. C.; Gordon L. Pickering, Honolulu, T. H.; W. P. Pohlman, Bethlehem, Pa.; Walter R. Prosch, Chicago, Ill.; R. H. Rehm, Bethlehem, Pa.; John A. Reynolds, Berkeley, Calif.; W. H. Richardson, Canton, Ohio; William J. Roehl, St. Louis, Mo.; Howard J. Rushton, Mt. Lebanon Township, Pa.; Irwin J. Russakov, Chicago, Ill.; Kenneth D. Ryan, Los Angeles, Calif.

A. E. Schoonmaker, Berwick, Pa.; H. P. Schowalter, West Bend, Wis.; J. H. Schreiber, St. Louis, Mo.; J. M. Seabrook, Princeton, N. J.; Warner Seely, Cleveland, Ohio; Raymond I. Shank, Hagerstown, Md.; William A. Sheppard, Pittsburgh, Pa.; Eric Carlton Sparling, Garden City, N. Y.; Carl G. Stifel, St. Louis, Mo.; W. H. Stocking, Coraopolis, Pa.; Ray C. Stoelting, Indianapolis, Ind.; C. J. Stroble, Brackenridge, Pa.; Richard H. Thach, St. Louis, Mo.; Charles Thomas, Palisade, N. J.; Thomas Thompson, Brooklyn, N. Y.; E. G. Uhl, Bethlehem, Pa.; Howard W. Underwood, Jr., Detroit, Mich.; D. L. Van Syckle, West Point, N. Y.

Howard G. Wade, Hinsdale, Ill.; Edward Wangelin Wagner, St. Louis, Mo.; G. L. Weissenburger, Keokuk, Iowa; John B. Wilkes, Berkeley, Calif.; H. G. Williams, Oak Park, Ill.; Everett P. Winslow, Rumford, Maine; D. M. Wise, Maplewood, Mo.; Grayson C. Woodbury, Fort Riley, Kans.; A. C. Worsley, Bethlehem, Pa.; John Edward Wright, St. Louis, Mo.; John D. Wyatt, Fort Thomas, Ky., and Clyde R. Yates, Los Angeles, Calif.

NECROLOGY

MAJ. K. K. V. CASEY, charter member of the Army Ordnance Association and director of its Philadelphia Post, died October 18, 1938 at Wilmington, Del. He had been associated with E. I. duPont de Nemours & Company for thirty-three years, having entered the service of the Company in 1905. In 1921 he was appointed director of military sales of smokeless powder. His death removes from the ordnance scene an energetic and affable personality known and admired by many friends in the military service and in civil life.

Harris & Ewing

MAJ. K. K. V. CASEY

Kellogg Kennon Venable Casey was a descendant of Kentucky pioneers. Col. Richard Calloway, one of the first burgesses from Kentucky to the General Assembly of Virginia in 1777, was among his ancestors as was Capt. John Holder who took part in the Paint Creek Expedition, the defense of Boonesboro, and the Bowman Expedition. Little wonder that from his earliest years his deep love for the military rifle and for military affairs grew apace.

Son of John Joseph and Mary Calloway Casey, he was educated in the schools of New York City. He was a member of the 71st Infantry, New York National Guard. He participated in the Santiago Campaign and upon his return from active service devoted his energies to the betterment of marksmanship among Americans. This development started with his own training and in a short time he advanced to the top ranks among American and European marksmen. Soon his fame with the rifle had spread through Europe, and his reputation with the rifle and for authoritative knowledge of small-arms ammunition became world-wide. For years he was one of the best long-range rifle shots. In 1908 he was a member of the American Rifle Team which won first place at the Olympic Games. In the same competition he won second place for open individual rifles.

He was the only man to win the Wimbledon cup three times at the National Rifle Matches. This feat he performed in 1902, 1907 and 1908. The Wimbledon cup is one of the most coveted prizes in the rifle-shooting world. In 1908 he also won the Leech cup at the National Matches. In 1923 the War Department appointed him captain of the American team to compete in the international rifle matches for the Palma trophy. He had been a member of the Palma teams of 1902, 1903, 1907, 1912, and 1913.

Among his other victories with the rifle were: in 1902, the military championship of the United States; 1904, the national individual divisional match, and the Spencer match; in 1905, the Thurston match. He won the Inspectors' match four times, being a member of the New York team in 1901, 1902, 1903, 1904, and 1905. Between 1906 and 1908 Major Casey was a member of the Delaware National Guard and from 1909 to 1916 a member of the 2nd Regiment, Pennsylvania National Guard.

Major Casey became a member of the rifle smokeless powder division of the DuPont Company in 1905. Two years later he was transferred to the smokeless powder operating department and in 1911 to the military sales department. He became manager of the rifle smokeless powder division in 1914. During the World War he was active in the military sales department under Col. Edmund G. Buckner and in 1921 he was appointed director of military sales of smokeless powder.

Expert in his knowledge of military explosives, Major Casey had many interests. He was coauthor with Maj. H. C. Wilson, of the New York National Guard, of the book "Rifle Range Construction." In addition to his long service as a member and official of the Army Ordnance Association, he was a member of the National Board for the Promotion of Rifle Practice, an official of the Association of American International Riflemen, a director of the National Rifle Association, a member of the Sons of the American Revolution, treasurer of the Wilmington Symphony Orchestra, a member of the Society of the Army of Santiago de Cuba. As a musician he was interested in Wilmington musical organizations.

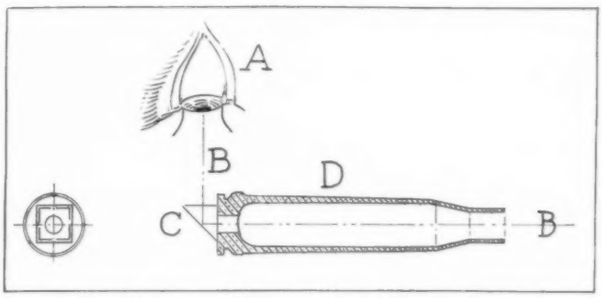
Thus passes from the ordnance scene a gentleman whose friendships and loyalties were second only to his ideals. In time of war he had important part in directing the tremendous operations of a great chemical company whose able executives, trained technicians and high-minded officials bent their every energy to victory. In time of peace he offered to both the Army and the Navy of the United States, without thought of remuneration, the counsel of an active mind and the experience of many years. To estimate the worth of Major Casey's many services to his country and to the manly art of rifle shooting is difficult because his contacts were far-flung. But agreement would be unanimous that his guiding rule was to give of his best always. In so giving he won for his company, its researches and its products, and above all for himself, a depth of admiration and respect seldom exceeded. An important era in the history of rifle shooting in America no less than the development of smokeless powder for the Army and Navy of the United States in peace and war is too intimately associated with the name of Major Casey for followers of his ideals soon to forget him. L. A. C.

NOTICE also has been received of the death of the following members of the Association: P. C. Brooks, Chicago, Ill.; William B. Foster, Wilmington, Del.; T. E. Golden, Columbus, Ga.; Henry Herrman, Newark, N. J., and W. F. Stewart, Jr., Overland, Mo. To their relatives and friends ARMY ORDNANCE, on behalf of the Association membership, extends condolences.

Professional Notes

BORE-SIGHTING DEVICE FOR MACHINE GUNS

IN small-arms range firing one of the most difficult operations to perform with precision is the bore sighting of the machine gun or other weapon used for the firing. The traditional method is to remove the firing mechanism from the bolt and sight through the striker hole. One objection to this method is that the eye must be held a considerable distance to the rear of the sighting aperture because of the length of the average receiver.



BORE-SIGHTING DEVICE FOR MACHINE GUNS
(A) Eye of firer; (B) Line of sight; (C) Prism or mirror; (D) Cartridge case.

Last May, the Frankford Arsenal made up a device in the manner suggested by Lieut. Col. H. H. Zornig, Aberdeen Proving Ground, which was intended to remove this difficulty in the current procedure. The basis of the device is a prism, which, deflecting the line of sight through 90 degrees, permits placing the eye near the opening in the side or top of the receiver of the arm and therefore only a short distance from the sighting aperture in the rear end of the bore. The most convenient means for holding the prism in place is an empty cartridge case to the head of which the prism is attached. The primer pocket vent is then available for use as an aperture, and ordinarily is so employed.

A muzzle bore sight can be provided if desired. However, due to the smallness of the apparent circle presented by the bore at the muzzle, this ordinarily is not necessary.

SPERRY-RCA AUTOMATIC DIRECTION FINDER

AFTER several months of intensive flight tests in scheduled air transport service, a new radio aid to air navigation, known as the Sperry-RCA automatic direction finder, has been announced by the Sperry Gyroscope Company. This direction finder, when once tuned to a station, points continuously and automatically at the station so that the pilot need pay no attention to its operation, merely glancing at the pointer on its face.

Since November 1937, the Bureau of Air Commerce has required that all transport planes be equipped with a shielded loop antenna and direction finder to help locate the airplane and to make radio reception of the airway radio beams under adverse weather conditions more positive. Many excellent devices have been produced and installed in aircraft and have proved of great assistance to pilots, in many cases making it possible for them safely to keep schedules which would be hazardous without them.

Although these various direction-finder loops gave excellent information to the pilot, they required close concentration and attention, at times when the pilot perhaps was busily engaged with other difficult problems of flight. The new direction finder not only does everything that other direction finders have done

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3 FINAL DRIVES for 1 rear axle

1 Double Reduction Drive
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● NOW 3 types of final drive in a complete range of rear axle gear ratios are INTERCHANGEABLE in 1 Timken Axle Housing. Timken 3 for 1 Axles make it easy to fit the truck to the job . . . Make it easy to change over from one type of final drive to another when road and load requirements change.

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previously, but does it automatically and continuously without diverting the attention of the pilot from any other activity. At the same time it possesses several features which have not been available hitherto.

The Sperry-RCA automatic direction finder requires only that the pilot tune to a station. The pointer on the instrument indicates immediately the exact bearing of the station, and continues to give the bearing even up to the point of passing over the station. This is one of the most valuable features of the instrument because, in addition to having indicated the bearing of the station, it immediately shows the pilot when he has passed over the station and gives positive information to confirm the "cone of silence" which he may have received if he was flying on the regular radio beam. The cone of silence has been recognized as rather negative information because, as the term implies, it is a momentary complete absence of any signal.

Aside from locating the bearings of any station or obtaining a "fix" for the airplane, the automatic direction finder provides a radio means of obtaining a drift or "crab" angle at any given time. In other words, a pilot may tune in a station toward which he is flying and observe whether or not the heading of the airplane is constantly changing. It is only necessary then to turn the airplane to the right or left and note the difference between the actual heading of the plane and the direction of the station when the bearing is not changing to know the amount of drift or "crab" angle that the plane must take to make allowance for the wind. When flying along one of the regular beams, any station to the right or left of the course may be tuned in, and the pointer then will give immediate indication as to how far along the beam the plane has progressed. It also has been found that with the Sperry-RCA direction finder the automatic feature makes it possible to obtain bearings when radio conditions due to static are so bad as to make it virtually impossible to obtain a null or "no signal" when using the ordinary type of hand-operated loop.

Aside from the information which may be obtained from the automatic direction finder, the design of the instrument itself has many features that will recommend it to the pilot. The face is mounted horizontally so that azimuth readings are shown in the plane in which they actually are measured. This helps the pilot orient himself by visualizing the location of the station, with respect to the ship he is flying, as being in the direction of the pointer relative to the miniature airplane shown on the face of the instrument. The navigation scales eliminate all arithmetic which, no matter how simple, may lead to serious error if performed when the pilot is under stress.

All dials and switches, such as volume control, band-change switch, course-setting knob, station-frequency indicator, station-tuning dial, antenna switch, antistatic switch, lighting control, are placed on the instrument within easy reach but at the same time sufficiently spaced so as not to be confusing.

The fact that this device operates continuously and automatically permits it to be used as an auxiliary or checking device so that the pilot may confirm with a glance whether or not he is on the course plotted by some other form of navigation.

The service tests and pilot training in the technique for operating the new automatic direction finder have been conducted under the supervision of J. G. Flynn, Jr., superintendent of communications of American Air Lines and chairman of the subcommittee for Radio Direction Finding of the Radio Technical Committee for Aëronautics.

If any article in this issue will be of interest to a friend of yours, send his name, address and the title of the article to ARMY ORDNANCE, *Mills Building, Washington, D. C., and a complimentary copy will be forwarded to him without obligation.*

Ordnance in Review

AN AMERICAN HERITAGE, PART VI

BY LIEUT. COL. CALVIN GODDARD, ORD. RES.

IT DID not take the Winchester Company long to realize that the cartridges for which the model '73 was designed lacked both range and energy. In fact, all these were but hybrids intended to function *both* in rifle and revolver and, consequently, incapable of their best performance in either. The answer was the '76, or "Centennial" model. This was nothing but an overgrown '73,

FIG. 21. THE KENNEDY REPEATING RIFLE, CALIBER .44

with larger frame and lengthened receiver, chambered for the .40-60, .45-60, .45-75, and .50-95 cartridges, the over-all length of these being sufficiently uniform to permit their functioning smoothly in the same action. Thus the owner of such an arm, desiring a change of caliber, could accomplish this through the simple expedient of installing a new barrel.

But the design was not sturdy enough to permit the use of really high-powered ammunition, and the piece did not enjoy a long life, being discontinued in 1897. Nevertheless it did offer energies, velocities, and ranges not approached by the '73, as indicated by the following comparisons:

Model	*Caliber*	*Bullet Wt.*	*Muzzle Veloc.*	*Muzzle Energy*
'73	.44–40	200 grains	1300 ft. secs.	752 ft. lbs.
'76	.40–60	210 "	1562 " "	1209 " "
"	.45–60	300 "	1315 " "	1152 " "
"	.45–75	350 "	1470 " "	1679 " "
"	.50–95	300 "	1493 " "	1490 " "

The .45-75 was an extremely effective cartridge for its time, and Gould tells us that "it has probably killed more large game than any other cartridge (1892). It has killed thousands of times with a single shot nearly every kind of big game within the borders of our country. It shoots with great accuracy up to 800 yards, and when designed was considered a superior hunting cartridge, a reputation it has never lost."

Of the .40-60 (the only one of the '76 series still currently manufactured), he says: "The .40-60 Marlin and Winchester are good hunting cartridges." He refers to the .45-60 as combining "accuracy and considerable killing power," while the

FIG. 22. THE MARLIN REPEATING RIFLE, MODEL '81

.50-95 "is much more accurate than the .50-110 [*vide infra*], and better for American game; it will shoot well up to 300 yards."

An interesting fact in connection with the '76 model is that it was adopted (in .45-75 caliber) as the official weapon of the Canadian Royal Mounted Police, and used by them up to 1914—eighteen years after its manufacture was discontinued. The weapon produced for the "Mounties" was of special type in that the forearm extended almost to the muzzle, military fashion.

NO POWER LOSS
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The barrel was of carbine length (22 inches) and the weight 8¼ pounds. Sporting models had the conventional short fore end, and were made in practically the same varieties of barrel and magazine lengths as the '73.

By this time, other makes of lever-action, tube-magazine arms were coming into the field. Whitney, located, like Winchester, at New Haven, was producing the Whitney-Kennedy repeater in many calibers (Fig. 21), and Marlin was at work on his gun of similar general outline, later to appear as the model '81 (Fig. 22). Some of Burgess' patents were embodied in another

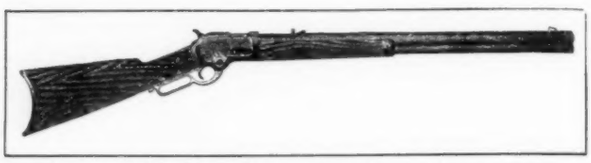

FIG. 23. THE COLT REPEATING RIFLE, CALIBER .44

variety offered by Whitney and first advertised in 1879 (in .45-70 caliber only). Others appeared in the .44-40 rifle released by Colt in July 1883 (Fig. 23), only to be discontinued the year following, after a total production of 6403, in favor of the pump-action tube-magazine arm known as the "Lightning."

Another lever-action tube-magazine weapon often referred to in contemporary literature but apparently never placed in production, was William Trabue's "Kentucky" rifle. This is discussed in Bartlett's "Weapons of War" (Washington, D.C., 1883) and illustrated by two cuts. It apparently was the only arm of its type in which the cartridges were transferred from magazine to barrel *without* the aid of the conventional carrier or "lifter"; hence it merits the following description (from Bartlett, pp. 50-51):

"The cartridges are forced back by the spring follower toward the receiver, in rear of the barrel. The bolt has a forward extension from its lower part. An incline in the bottom of the receiver rises toward the bolt far enough to prevent the passage of the head of the cartridge between the two. As the bolt is drawn back the cartridge follows, being forced by the spring in the magazine, and passing back of the incline the head drops down, the bullet being tilted upward, but being prevented from jumping out by the housing at the top of the receiver. When the bolt is closed the cartridge in the receiver rides on the projection of the bolt over the next one in the magazine, which projects partly into the receiver."

It is a matter of record that five types of lever-action, tube-magazine rifles were examined by a U. S. Ordnance Board which sat at Springfield Armory from March 1871 to May 1873 for the purpose of selecting a suitable new weapon for the armed forces, its findings being embodied in the report of the Chief of Ordnance for the latter year. These rifles were the Winchester, Stetson (withdrawn without test), Burgess (withdrawn with-

FIG. 24. THE BULLARD REPEATING RIFLE

out test), Beals (wooden model only), Rumsey (wooden model only).

The Stetson (U. S. patent No. 116,642) resembled the Winchester in general get-up. The Burgess has just been discussed. (See also Fig 19, Part V of this series, in ARMY ORDNANCE for Nov.-Dec., 1938, Vol. XIX, No. 111, p. 176.) The Beals was interesting in that operation of the finger lever brought the hammer to *half cock* only, whereas in conventional types it

attained full cock by this maneuver. The Rumsey, like the Shinn (Fig. 20, Part V of this series, Nov.-Dec. 1938 issue), had *two* tube magazines beneath the barrel, lying side by side and feeding cartridges alternately into the mechanism.

THE time was now ripe for a lever-action rifle which would handle ammunition of greater effectiveness than that for which the '76 was designed. Game was already being decimated in many localities. The buffalo was no more. Other animals were harder to find—harder to hit. But the action of the '73 and '76

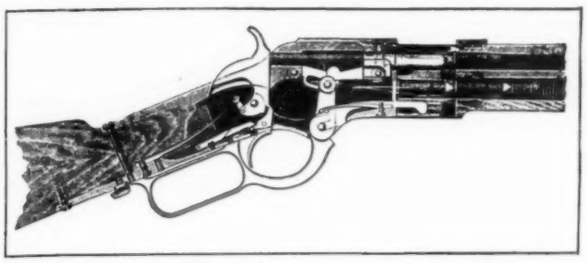

FIG. 25. WINCHESTER REPEATING RIFLE, MODEL '73, ACTION CLOSED

models appeared incapable of further improvement. Something radically new was indicated.

Winchester engineers went into a huddle and brought forth what even today represents about the last word in tube-magazine, lever-action, arms—the model 1886 (Fig. 26) which, though now discontinued (as of 1935), lives on practically unchanged in their model 71 of .348 caliber, and others of lesser significance.

With the '86 came a multiplicity of new cartridges and calibers, some good, some bad, some indifferent, but almost all superior, for repeating arms, to any which had preceded. Further, this was the first Winchester to be offered in both solid-frame and take-down types—the latter at additional cost. Issued at first in caliber .45-70, it soon was followed by the smashing .50-110-300 and the .50-100-450, then by the .38-56, .40-82, .45-82, .45-85, and .45-90. There followed the .40-65, .38-70, .40-70, and lastly the .33 W.C.F.

The '86 saw in its lifetime the transition from black to smokeless powder. Originally developed while the former still reigned absolutely supreme, the date of its discontinuance found smokeless powder in full command of the field. It was the first Winchester model to use (in caliber .33 W.C.F.) a purely smokeless cartridge, and managed to keep abreast of later offerings through the gradual adaptation of smokeless loads to the various cartridges, originally built for black powder. Comparison of Fig. 25 with Fig. 26 will reveal the substantial changes embodied in its mechanism as contrasted with that of its famous ancestor of 1873. And since these changes carry on, with unimportant modifications, through all the succeeding lever-action, tube-magazine models issued by the Winchester Company from 1886 to the present day, this well may conclude our narrative so far as the products of that firm are concerned.

Before touching upon other makes and makers, however, reference should by all means be made to the excellent article on the '86 Winchester, "The Passing of the '86," by Capt. A. P. Wescott in ARMY ORDNANCE for January-February 1937, Vol. XVII, No. 100, p. 239 a perusal of which will reveal much of additional interest concerning this grand old product.

Marlin's model of '81 was followed by that of 1888, resembling the former in that it, like all tube-magazine, lever-action rifles theretofore commercially produced, embodied the feature of "top" ejection (ejection of fired case from top of receiver). But in 1889 he released his first model with "solid top and side ejection," a phrase which has been the Marlin slogan descriptive of this feature from that day to this. Satterlee accords

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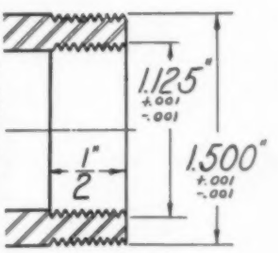

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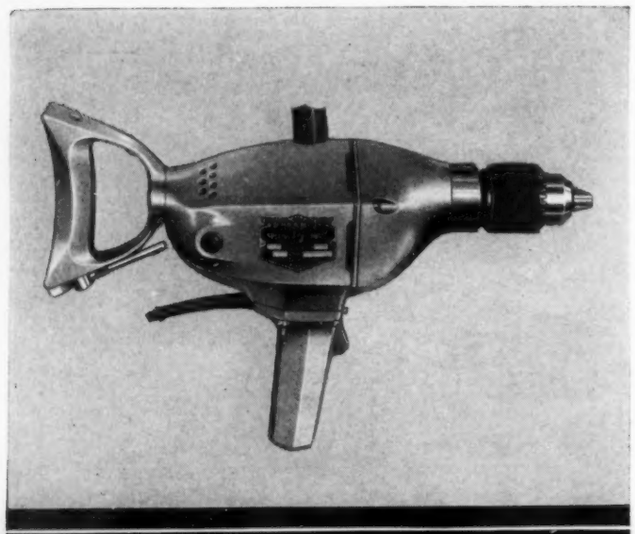

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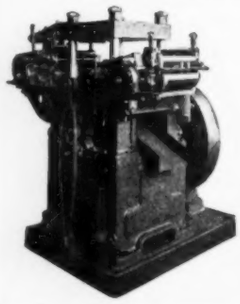

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the actual invention of this design to Hepburn, of Hepburn-Remington fame.

Almost contemporary with the '86 Winchester was the Bullard, an arm patented in 1886 and first marketed in 1887 (Fig. 24). It differed radically from previous weapons of its type in that the lever actuated the bolt not through links or cams but through a rack-and-pinion device—a very positive and satisfactory mechanism with much to commend it. Like the '66, '73, and '76 Winchesters, its carrier was of brass, not steel, and reciprocated in a vertical well in the receiver. This disappeared as a Winchester feature on the advent of the '86 model. It was chambered for a series of cartridges from caliber .32 to .50 most of which were adapted to no other make of rifle, the latter being known as the ".50-115-300." The case for this mammoth slug was of the semi-rimless variety and so much resembled many of much more modern origin that fairly advanced collectors unfamiliar with it are loath to believe it dates back to the late 'eighties.

A fine piece of mechanism, the Bullard apparently lacked the financial backing necessary to make it a success. It struggled a few years for a foothold, then succumbed. Had it been made for a line of cartridges already popular, instead of one the majority of which were untried, the story might have been different.

MORE than two decades passed without the appearance of another entrant into the lever-action, tube-magazine rifle field. Bolt-action advocates smugly assumed that this type of arm was "through." Then suddenly, in 1910, the Stevens firm astonished the gun trade by bringing forth its high-power lever-action repeater (with tube magazine), chambered for the full line of Remington auto-rifle cartridges (calibers .25, .30, .32 and .35) and embodying the "solid top and side ejection" theretofore peculiar to Marlin products. Launched upon a keenly competitive market already monopolized by Winchester and Marlin, this model never flourished and was discontinued in 1918. It had the disadvantage of an extremely long lever throw, and apparently lacked those superior features which it would have had to embody in order to gain "a place in the sun."

Thus ends our tale. Today, the lever-action mechanism, the

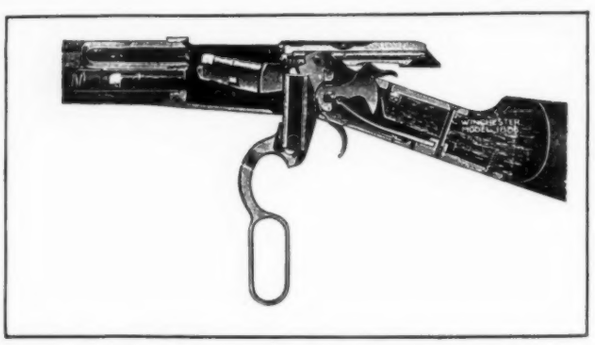


FIG. 26. WINCHESTER REPEATING RIFLE, MODEL '86, ACTION OPEN

stand-by of our fathers and grandfathers, is fighting for its life against bolt-actions, automatics, and "pump" types. And the fight appears a losing one. In the more powerful calibers, the bolt-action is undoubtedly the strongest and likewise the best adapted to rimless cartridges with their tricky headspacings. In the low-power class, a satisfactory bolt mechanism with clip feed can be turned out much more cheaply than can one involving a lever action, with tube magazine. So the latter is hard hit. But it dies hard and it is likely that yet more generations of riflemen will come and go ere the last lever-action, tube-magazine repeater departs to that Valhalla where rest the shades of these old warriors—blessings on their memory! (*Concluded.*)

Ordnance Patents

PATENTS for ordnance and related equipment issued during 1938 include the following:

A pneumatically operated loader for medium- and large-caliber guns arranged to reduce the loading time and which will load at an angle of twenty degrees; to Maj. Elmer C. Goebert and Victor F. Lucht (No. 2,112,853).

A data computer for solving problems arising in the control of machine-gun fire; to Capt. Otis McCormick (No. 2,112,858).

A trail and drawbar connection for gun carriages which permits shifting of the trails; to Orie L. Beardsley (No. 2,115,002); also a rugged crank axle which may be attached to the usual axle and spindle of a gun carriage so as to mount pneumatic-tired wheels thereon (No. 2,103,792); also a gun-trail spade braced by a curved plate secured to the spade along its edges so as to permit lateral displacement of the spade when in use (No. 2,104,015).

An apparatus for testing cartridges to determine variations in the powder charge of components; to George A. Miller, Jr., William Miller, G. D. Noble and E. R. Willis (No. 2,115,032).

A tracer bullet which begins to trace only when the bullet is some distance from the gun; to Thomas Stevenson and Ernest R. Rechel (No. 2,115,047).

A means for cooling gun barrels which provides a sleeve or jacket formed of a light metal in close contact with the gun barrel so that a jacket of considerable wall thickness may be used without adding unduly to the weight; to Major Richard C. Coupland (No. 2,112,144).

A moisture-proof wrapper for preserving the contents of a package, especially in adverse conditions such as are met within the tropics, and means for readily removing the wrapper; to James C. Karnes and Gregory J. Kessenich (No. 2,106,748).

A latch intended to hold two members which are threaded together in the desired relationship. The latch is provided with serrations which engage serrations on the threaded members, the serrated portion having a slight camming action which holds the latch in closed position; to William R. Bluehdorn and Forrest K. Howard (No. 2,108,040).

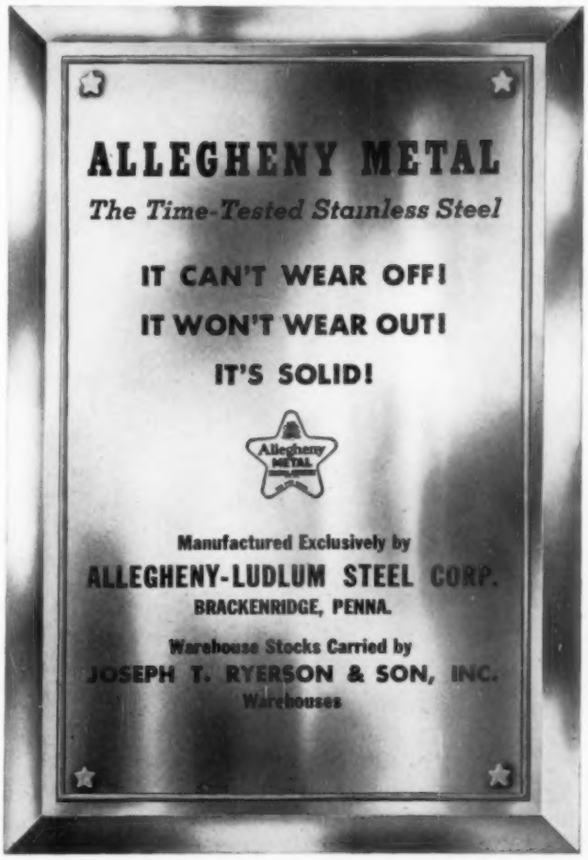
A back-plate latch for machine guns carried at the lower portion of the back plate. The latch engages the bottom plate of the receiver and is operated to unlatch in the direction of removal of the back plate. The latch normally is locked in latching position by an auxiliary latch; to Samuel G. Green (No. 2,108,060).

A modification of the Browning machine gun, caliber .30, as modified to shoot caliber .22 ammunition. It consists in providing holders for the ammunition which are of the size and form of caliber .30 cartridges. This allows use of the usual belt and feedway; to Filser D. Hoppert, William R. Bull, and Clarence E. Simpson (No. 2,108,817).

A practice bomb which is filled with inert material through a tube extending to the tail of the bomb. This tube is utilized for holding the firing mechanism which sets off an expelling charge to expel powdered talc or the like; to Maj. Sargent P. Huff and Arthur Adelman (No. 2,108,818).

A machine-gun cart consisting of a bar or tube to the ends of which crank axles are secured carrying wheels. Seats and clamps are provided on the crank axles to receive and secure in place the feet of the front legs of a tripod the trail leg of which is used to draw the cart when traveling; to Maj. Sidney H. Negrotto (No. 2,108,826).

A bolt handle designed primarily for large-caliber machine guns, so constructed as to give an initial leverage to start the



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heavy bolt in motion and also constructed to permit the bolt to reciprocate during firing without reciprocating the handle; to Samuel G. Green (No. 2,104,033).

A suspension for vehicles in which the crank arm connected to the vehicle body and the crank arm carrying the wheel are each connected through a torque-resisting joint which takes the normal load; the arms are further interconnected through a torque-resisting joint which normally carries no load and only acts upon change of load; to Harry A. Knox (No. 2,100,338).

A grenade which may be thrown by hand or projected from a grenade thrower by a propellent charge. The grenade has two primers, one of which acts when the grenade is thrown by hand and the other when projected from a grenade thrower; to John M. King (No. 2,101,071).

A bomb fuze of the mechanical time-fuze type in which a member released by a wind vane prevents the clockwork mechanism from functioning until the bomb has cleared the airplane; the fuze is also constructed to fire on impact should impact occur before the time for which the fuze is set; to Marvin L. Mathsen (No. 2,101,082).

A light machine gun of simple construction in which the cartridge is forced directly from the belt into the cartridge chamber; to Capt. Wiley T. Moore (No. 2,101,086).

A special arrangement of operating rod and springs in a gas-operated gun; to Lieut. Col. Stephen H. MacGregor (No. 2,101,862); also an apparatus in which cooling of a gun barrel is accomplished by expansion of a compressed gas (No. 2,126,-792).

A gun barrel mounting which will allow for radial and longitudinal expansion of the barrel and will enable the barrel to be cooled sufficiently to insure its reciprocation in the cradle while maintaining a high rate of fire; to August Dabrasky (No. 2,125,-892).

A device for efficiently holding a thin sheet of material while being cut; to Clarence E. Harris (No. 2,125,919).

A telescope sight mounting for use in tanks. Instead of adjusting the sight to range, it is adjusted to have the line of sight converge with the line of fire at a definite range; to Robert J. Lennen (No. 2,125,932).

A transmission of the automatic continuously variable type especially arranged to accomplish steering of a track-laying vehicle by driving the tracks at different speeds; to Capt. Robert K. Haskell (No. 2,126,772).

A position-finding instrument comprising a large night glass associated with a stereoscopic range finder and with sound-locating apparatus; to James C. Karnes (No. 2,138,035).

A target which may be towed at high speeds by air or surface craft, maintaining a constant altitude; to W. E. Yocum (No. 2,135,549).

All of the following patents were granted to Samuel G. Green:

A muzzle attachment for guns so arranged that cooling fluid is kept is circulation about the muzzle of the gun barrel (No. 2,101,063).

A recoil check and flash hider in which the muzzle end of the gun reciprocates in a bearing provided with radial vents which communicate with the atmosphere (No. 2,101,848).

A muzzle attachment for guns providing an expansion chamber for the gases prior to discharge into the atmosphere, the whole being surrounded by a cooling jacket (No. 2,101,849).

A machine-gun jacket mounting providing a trunnion block formed to mount various types of jackets (No. 2,101,851).

A gun-barrel mounting providing construction for circulating the cooling medium about the muzzle end of a gun barrel (No. 2,102,622).

A recoil check and barrel accelerator for machine guns arranged to prevent accumulation of carbon and fouling of the barrel bearing (No. 2,128,243).

A wrench in which the handle and jaws are mutually supporting; to Samuel G. Green and Robert J. Lennon (No. 2,128,244).

Book Reviews

THE RIFLE IN AMERICA. By Philip B. Sharpe. New York: Wm. Morrow & Co. $7.50.

PHIL SHARPE, the ubiquitous, the irrepressible, the indefatigable, has done it again! Scarcely is the type dry on his handloading volume when he bursts forth with an opus which reminds one of the accumulated efforts of Sawyer, Satterlee, Whelen, Gardner, and the fair-haired boys who compose the gunmakers' catalogues, all rolled together.

To any reasonable mortal, the release of a work such as Sharpe's on handloading would constitute sufficient excuse to lie back on his laurels for a spell, and a pretty long one at that. Not so with Phil. That young man appears to have drawn down the center of his workroom an artificial international date line. For twenty-four hours he works on one side, then slides his desk across it and puts in another twenty-four, all in the space of one calendar day! By no other means would it be possible for him to accomplish what he does.

Yet the result gives scant evidence of hasty preparation or lack of adequate documentation. Instead it suggests painstaking research into a million musty archives, plus, what is even more pertinent to success in such an effort, an uncanny knowledge of *where* to seek the necessary information.

Divided into thirty-one chapters and embellished with excellent photographs and line drawings, the text includes brief histories of all the most famous American rifles and their makers. Products of Sharps, Remington, Winchester, Stevens, Colt, Ballard, Marlin, and Newton, not to mention those relative newcomers in the rifle field—Iver Johnson and Mossberg, are discussed in chapters ranging in size from two pages (Iver Johnson) upward. In these portions of the volume the arms student will find much meat, for Sharpe has carefully digested the early catalogues of the makers named, and presents a list of models, calibers, weights, finishes, and dates of introduction and discontinuance not to be found elsewhere within a single cover.

In still another chapter, entitled "The Early American Cartridge Rifle," Sharpe groups those makes and makers to which he has not seen fit to accord individual chapter listings. And he has done a good job. Yet the space devoted to the entire lot (fifty-five pages) seems scant when we realize that an equal coverage is given to Winchester alone. This is doubtless due to a paucity of available data on the more obscure varieties. But, in addition, the author has omitted mention of a number of fairly well-known American rifles. In a brief survey I listed twenty-three of these, which would suggest that the total tally of those "not present" would probably run considerably beyond this figure. This is unfortunate, but we scarcely can hope for omniscience.

Other chapters include one on the early Springfield, and another on the development of the cartridge—the latter reflecting Sharpe's deep interest in and knowledge of metallic ammunition. A lengthy discussion of telescopic sights, containing very comprehensive information, fills a chapter of twenty-seven pages.

Other chapters include, "The Percussion Rifle," "The Small Game Rifle," "Metallic Sights," "Home Gunsmithing," "The Custom Gun," "Military Rifles of the World War," and "The Future American Rifle"—this carrying a last-minute description of the new Garand semiautomatic arm.

A review of the chapter headings suggests that perhaps Sharpe has attempted to be a little too all-inclusive, and to have prepared a compendium or encyclopedia on rifles and their ammunition rather than to have adhered strictly to the history, evolution,

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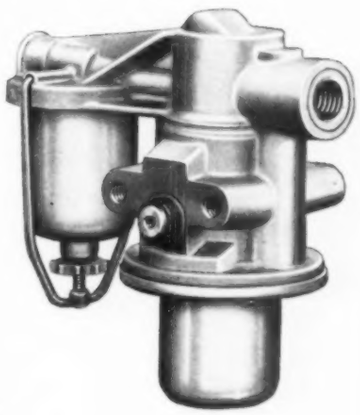

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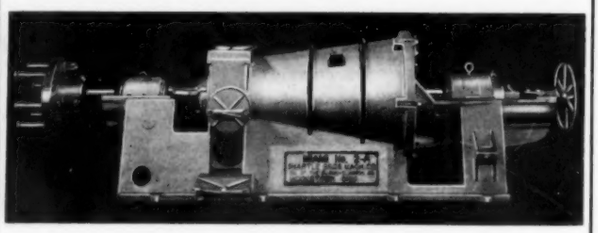

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and present state of the rifle in America. This may be true, yet the additional information supplied will prove of great interest to a large proportion of readers, and for his part, the reviewer would hate to have missed any portion of it.

The typography of the volume is clear and pleasing, and the illustrations are for the most part well chosen, though it is to be regretted that many of the rarer types of arms described are not depicted. A little more effort might well have been devoted to securing and exhibiting cuts of these. Further, some of the items shown are mislabeled (through interchange of captions), and in one instance at least, the caption has been omitted.

With a number of Sharpe's statements of fact, the reviewer takes issue. Thus he doubts that "the rim-fire was the first truly successful metallic cartridge," since it admittedly did not appear until 1856, at which time the pin-fire was fully a decade old (two decades, according to some authorities), and had proven successful enough to be adopted for use in military side arms by the French Government. Space adequate to a full discussion of other debatable points is lacking. Suffice it to say that these are not sufficiently numerous, or important, to detract materially from the value of the work even should the author be proven in error in every instance.

There are likewise a few cases in which Sharpe has slipped, though he knows better, as when he refers to a Remington "rolling-block" action as a "falling-block." Such deviations are fortunately rare. Nevertheless, they should have been caught and corrected in the proof reading.

From the standpoint of editing, the volume deserves no praise. Such puerile errors as singular subjects followed by plural verb forms (or vice versa), an adjective where the adverb is required, the incorrect use of "lay" and "lie" are frequent.

To summarize: The present volume, complementing his earlier "Handloading Ammunition," places Sharpe in the position of being today's outstanding contributor to arms literature. Bits of his work may show indications of insufficient seasoning, hasty preparation, or failure to consult *all* of the available source material. Against this criticism he well may demand, "Show me him who has done as well, or better." We cannot.

He is still a young man and—with the ability, resourcefulness, and industry which are his—a young man who intends to go places. And he will. C. G.

THE YANKEE CHEESE BOX. By Robert Stanley McCordock. Philadelphia: Dorrance & Co. $3.00.

THIS narrative account of America's first ironclad warships is wider in scope than might be assumed from the title. Although about half the book's twenty-seven chapters contain a complete description of the planning, building, combat, and destruction of Captain Ericsson's MONITOR, and of her equally well-known adversary, the MERRIMAC (more properly, though not customarily, the C.S.S. "VIRGINIA"), Professor McCordock brings into his work much of the general question of ironclad warships and also the temper and reactions of the governments and the peoples of the North, the Confederacy, and Europe.

The greatest weakness of the book, undoubtedly is its immense amount of direct and extended quotation from the press of the time as well as from individuals. These quotes are so repetitive and overlapping and contain so many rather meaningless jokes and puns of the day that they sometimes become tiresome.

Wholesale editing and condensing of such matter would make for a more readable book. The volume, with this filling matter eliminated, might well be reduced to but half its present size of 406 pages plus 62 pages of references. An introduction by Rear Admiral Hepburn stresses the high points of the volume, and also notes the abysmal ignorance and indifference of our youth to their country's history.

The question of the great part in naval progress played by the MONITOR and the MERRIMAC is ably handled and some hoary myths exposed. Thus, the average reader will be amazed

to learn that in 1861 there were built or building no less than one hundred ironclad vessels of war. The controversy still rages as to the comparative merits of the MONITOR and the MERRIMAC. Nothing conclusive can be said, though there seems little doubt that if her miserable engines could have been replaced, the Confederate ram would have been the more powerful fighter. The same controversy extends to the combat between the two. Victory has been, and still is, claimed for both ships. The truth seems to be that both vessels were so experimental, and both owned to so many shortcomings, that it was "anybody's fight." Although the author unfortunately does not put many conclusions into words, some valuable lessons may be drawn from his work. The tendency to assume that any new and radical military or naval device will revolutionize rather than merely modify warfare, is as great today as in 1862. Then there is the analogy between the hysterical terror throughout the North, caused by the MERRIMAC, and the insensate terror, exaggerated out of all proportion, caused today by the threat of air bombing.

The greatest, as well as the bitterest lesson, however, which cannot fail to be drawn from careful perusal of "The Yankee Cheese Box," has to do with the press. The colossal folly of fighting a war in the newspapers, and the utter inability of the civilian mind to grasp the simplest military problem, is demonstrated on nearly every page. The ridiculous extravaganza of swiftly alternating panic and overconfidence displayed by the entire press of 1862, and the apparent determination of most of it to print anything that would sell papers, regardless of any damage to the nation or to the peace of the world, constitutes a first-class argument for a "controlled press." Such a welter of contradictions, snap judgments, and wild fictions, savors more of bedlam than of a responsible institution. Its vain boastings, invective, and taunts against Britain and France made it a menace to the peace of the world, as well as to the safety of the nation.

One is forced to the conclusion that the vastly greater part of the American press was in the hands of incompetents who could not separate wild rumor from fact, or of scoundrels who simply did not care what they printed. And from the factual record of the past few years, when the "crises boys" ran wild in most of our newspapers in an orgy of anti everything that smacked of discipline, it is difficult for this reviewer to see any improvement to date! F. W. F. G.

ED MCGIVERN'S BOOK ON FAST AND FANCY REVOLVER SHOOTING. Springfield, Mass.: King-Richardson Co.

FOR some years past there have been filtering out of the West tales of a superman who could make revolvers do tricks never done before. His name was McGivern, and he held forth somewhere in Montana. Tall yarns were spun about his getting off five shots in half a second or less—shots all of which would group in the space of a man's hand at twenty feet—of his cutting in two edgewise with a bullet a playing card tossed into the air, putting four holes through a nonshattering clay pigeon flung skyward before it could hit the ground, and other ridiculously impossible feats. All the boys who are wont to take thirty seconds squeezing the trigger of a target arm, only to score a nipper "eight" at twenty yards, announced that they were from Missouri. I was one of them.

Now everything's different. Ed McGivern has released to the world in "Fast and Fancy Revolver Shooting," the breathtaking epic of what *can* be done with a revolver by a man willing to devote the time, effort, and money necessary to explore its potentialities. Electrical timing devices attached to experimental weapons, accurate to the minutest fraction of a second, have recorded the facts. "The quickness of the hand deceives the eye," but it can't deceive the galvanic impulse or the revolving drum on which the indicator pens write their story. It can't be true—but it is.

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SKILLED hands that first fashioned the high-power vacuum tube and the modern x-ray tube, that made history in radio tubes, phototubes, and sodium lamps. They are the hands of craftsmen in the General Electric Research Laboratory, where were built the first models of many new devices which now play an important part in modern civilization.

Scientific research combines the contributions of mathematician, experimenter, and craftsman. It furnishes the new knowledge which industry is able to translate into an abundance of necessities and comforts—into more goods for more people, at less cost. And toward this goal G-E research is making significant progress.

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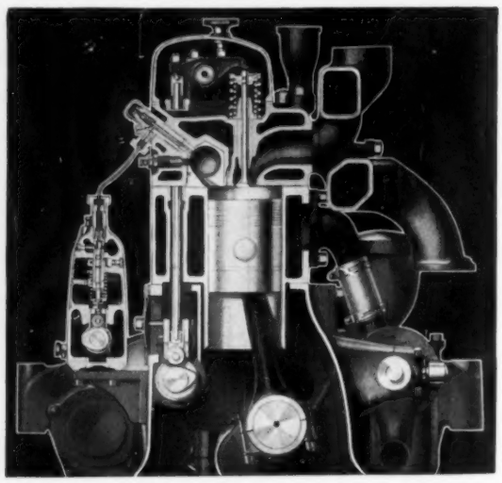

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The whole volume is so subversive of long-established theories and opinions, so fresh and illuminating, that in this reviewer's opinion, there is just one person competent to review it adequately—Ed McGivern. But since that gentleman would, if requested to do this, probably manifest a delicate diffidence, we can but suggest that the only satisfactory way for the layman (*i.e.*, everybody in the world *except* Ed McGivern) to gain an idea of its scope, its interest, its revolutionary import, is to secure a copy and peruse it himself.

He will find chapters on shooting at stationary and aërial targets, two-gun training, speed shooting with single-action revolvers, double-action shooting *vs.* single-action, trigger control, shooting psychology, correct measurement of short time intervals, hip shooting, the quick draw, converting arms for special purposes, revolver training for law-enforcement officers, sights, spotting 'scopes, holsters, belts, and other accessories, long-range revolver shooting—but let's stop there. Disregarding groups and records made at lesser ranges, we may refer to a silhouette target (of the human body) illustrated on p. 417 of the work, at which ten shots were fired (by hand) from a caliber .357 Smith & Wesson "Magnum" revolver with 8¾-inch barrel at a distance of 600 *yards* (no, *not* feet). There are four hits on the body, three in one arm, and one on the paper background just off the arm. Good? It's perfect! Get the book and read it. You'll not be sorry. C. G.

Notes on French Ordnance, 1917 to 1936. By Capt. James E. Hicks. Mt. Vernon, N. Y. $3.50.

THIS is an unique volume, printed by the planograph process, bound in linen covers and replete with 175 pages of drawings and sketches. Never before has this reviewer seen assembled in one place in the English language so lengthy a discussion of military equipment of any one country over a definite period. Captain Hicks describes all the principal French types of military armament over a period of 219 years. And of course French design and practice during much of this period—the great era of mechanical progress—lead the field. The author's drawings are embellished by eighty original plates, the work of M. Andre Jandot.

While there may be divergencies of opinion as to the given characteristics of certain pieces, this book has an authenticity which comes from great detail. Captain Hicks has devoted many years to the preparation of his subject and has blazed a trail where others well may follow. His work emphasizes that for American ordnance in its historical development we have nothing other than the now obsolete "Handbook of Ordnance Data" issued during the World War to familiarize citizen soldiers with the why and wherefore of ordnance types. The need grows from year to year for a series of volumes on American ordnance. It is to be hoped that soon we may review in these pages "Notes on American Ordnance, 1776 to 1939"! L. A. C.

Rusty, A Cocker Spaniel. By Maj. S. P. Meek, Ord. Dept., U. S. Army. Philadelphia: The Penn Publishing Co.

THIS is another of Major Meek's incomparable dog stories. Rusty is a diminutive red cocker spaniel whose outstanding characteristics are courage, devotion to his mistress, and intelligence. Seeing the dog in the window of a pet shop, his mistress purchases him over the protests of her fiancé, a noted breeder of cocker and springer spaniels. Rusty is an undersized runt, has no show points, and his pedigree is unknown. But eventually Rusty wins the Open All-age Stake by an exceptionally long retrieve and is registered in the American Kennel Club.

The author is a charter member of the Army Ordnance Association, an officer of long service in the Army, and the author of six books of animal stories including "Franz, A Dog of the Police" and two other volumes of adult fiction. O. E. D.